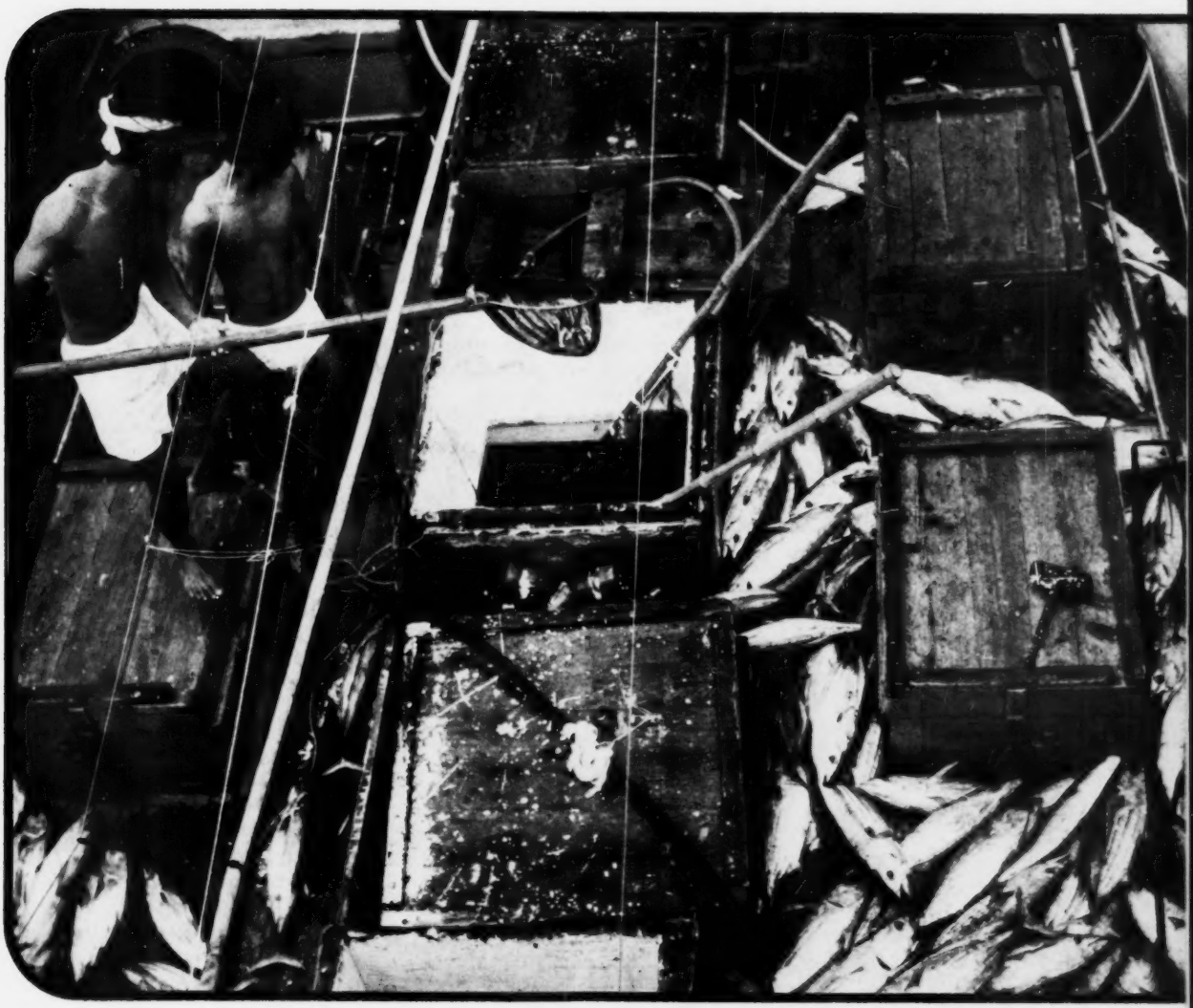
Volume 37 Number 2 February 1975

Marine Fisheries REVIEW

National Oceanic and Atmospheric Administration • National Marine Fisheries Service



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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director, Office of Management and Budget, through May 31,1975

Managing Editor: Willis L. Hobart

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $1.35 (single copy). Subscription price: $15.25 a year, $19.10 a year for foreign mailing.

Marine Fisheries Review

Vol. 37, No. 2
February 1975

CONTENTS

Articles

Departments

Cover.—Bait is dipped by skipjack fishermen off Papua New Guinea (see MFR Paper 1120, page 5). Photo courtesy of the Department of Information and Extension Services, Papua New Guinea.

MFR PAPER 1119

Trends in Catch-Effort Relationships With Economic Implications: Gulf of Mexico Shrimp Fishery

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This paper is Technical Article No. 11436 of the Texas Agricultural Experiment Station. The research upon which it is based was supported in part by funds provided by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, under Contract No. 03-3-042-19 with the Texas Agricultural Experiment Station.

INTRODUCTION

The shrimp fishery of the Gulf of Mexico is the most valuable in the United States. Government-collected statistics are published regularly on catch and total value of shrimp by months and years and for each major Gulf port. In 1973 landings of shrimp at U.S. Gulf ports by all vessels were estimated to be 114 million lb (heads-off) valued at $173 million.

The long-term viability of a fishery is dependent on many factors, both biological and economic. The size of the biomass, reproduction capabilities, and other factors affecting the physical quantities available to be landed describe only part of the important considerations for the industry. Equally significant are measures of fishing effort, prices, costs, and returns in the economic realm of analysis. An analysis of the condition of a fishery should include all of these.

This paper reviews the recent trends relating to catch and fishing effort in the Gulf of Mexico shrimp fishery. The scope of this report is limited to presenting some of the basic findings in a descriptive format using simple time series and trends to illustrate the relationships developed.

The information presented is based on data collected from all vessels of 5 GT and larger landing shrimp at U.S. Gulf ports. The basic data series utilized are drawn from the records collected by the National Marine Fisheries Service (NMFS) and summarized in Table 1. The index used to estimate fishing effort was developed under a research contract with the NMFS and is described in the detailed report presented at the completion of that contract[1].

The analysis was limited to the years 1962 through 1971. Although more recent data were not available at the time the research was completed, most of the series have been extended to reflect conditions in 1972 and 1973. This was done to better reflect the current status of the industry. While certain assumptions were necessary, published data sources were used in addition to the basic relationships established for the 1962-1971 period so that the estimates for 1972 and 1973 are adequate for the purpose of illustrating current trends in the industry. Detailed discussion of the basic research procedures and results will not be presented here as they are available elsewhere[1,2].

TRENDS

Effort

Some measure of the amount of effort expended in a fishery is important for the purpose of evaluating the underlying causes of a change in landings which may be occurring. One

[1]Griffin, W.L., M.L. Cross, R.D. Lacewell, and J.P. Nichols. 1973. Effort Index for Vessels in the Gulf of Mexico Shrimp Fleet. Contract Research Report to the National Marine Fisheries Service. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University, College Station, TX 77840.

[2]Griffin, W.L., J.P. Nichols, and R.D. Lacewell. 1973. Trends in Catch/Effort Series: Gulf of Mexico Shrimp Fishery. Contract Research Report to the National Marine Fisheries Service. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University, College Station, TX 77840.

Table 1.—Selected data series, Gulf of Mexico shrimp fishery, 1962-1973[1]

Year	Number of Vessels	Days Fished	Index of Effort	Total Effort[2]	Catch by Vessels[2]	Total Gulf Landings	CPUE[2]	Ex-vessel Price	Gross Revenue/ Vessel
		(1,000)		(1,000)	Million lb (Heads-off)	Million lb (Heads-on)	lb	$/lb	$
1962	2,542	128	1.26	161.6	64.6	141.7	399	.76	19,319
1963	2,653	140	1.07	149.6	91.3	203.1	610	.57	19,621
1964	2,795	141	1.15	161.4	89.8	179.0	556	.59	18,959
1965	2,804	141	1.16	163.8	97.9	195.2	597	.63	21,992
1966	2,924	132	1.20	158.2	89.0	179.2	562	.80	24,350
1967	3,098	134	1.36	182.3	110.0	225.7	603	.71	25,219
1968	3,346	144	1.56	225.9	98.3	204.0	435	.84	24,668
1969	3,362	175	1.48	259.0	91.1	200.4	351	.92	24,925
1970	3,298	147	1.58	232.9	105.3	230.5	451	.86	27,449
1971	3,282	153	1.62	248.2	100.6	227.1	405	1.12	34,317
[3]1972	3,535	169	1.72	290.7	104.6	228.5	361	1.32	39,176
[3]1973	3,574	170	1.80	306.0	83.1	181.4	271	1.73	40,306

[1]All data series except total Gulf landings are derived from NMFS data tapes on Gulf of Mexico shrimp landings by vessels of 5 GT and larger. Data for 1972 and 1973 are projections from this data base and other published sources.
[2]Relationships between total effort, catch, and CPUE have been estimated from data in this table and have been presented in text footnote 2. These results will be reported in forthcoming publications.
[3]Projections by authors.

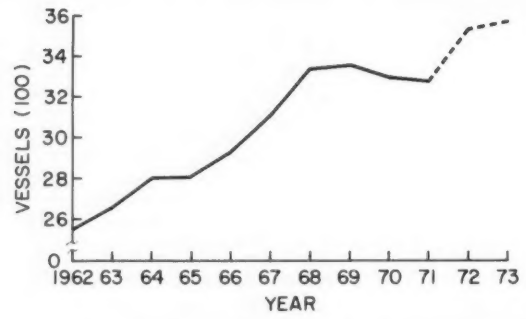

Figure 1.—Number of vessels 5 GT and larger reporting shrimp landings, Gulf of Mexico, 1962-1973.

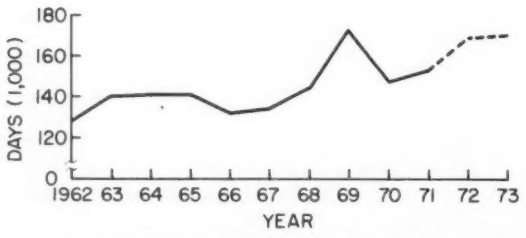

Figure 2.—Total days fished by vessels 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

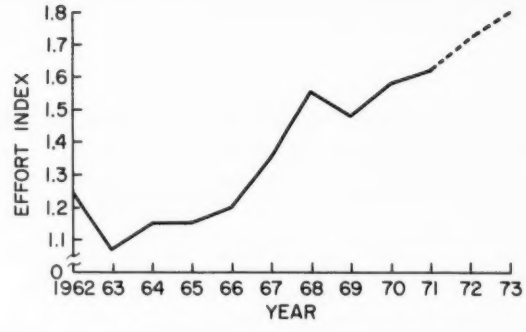

Figure 3.—Index of fishing effort for the average vessel 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

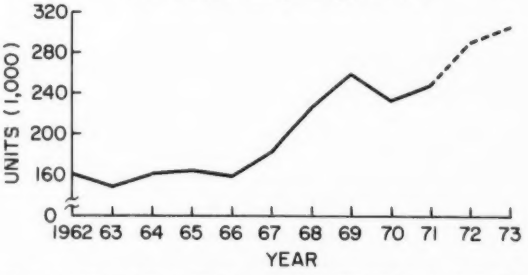

Figure 4.—Total fishing effort by vessels 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

basic indicator of the trend in fishing effort is the number of vessels operating in the fishery. Illustrated in Figure 1 is the number of vessels of 5 GT and larger reported to have landed shrimp at a U.S. Gulf port each year. In 1962 the number was 2,542 vessels. This had increased by 24 percent through 1971 when 3,298 vessels reported landings. The same general upward trend is projected to have occurred during the last 2 yr related to prospects for profits in the industry (over 3,500 vessels in 1973).

Another factor important to the determination of fishing effort is the total number of days fished (Fig. 2). In the Gulf shrimp industry, this figure increased about 9 percent from 1962 (140,167 days) to 1971 (153,058 days). Each day in this case represents a full 24-h. period of actual time on the grounds. An unusually large number of days fished was reported for 1969, apparently related to very favorable weather conditions. Analysis of preliminary data for 1972 and 1973 permitted a projection which shows an increase to 170,000 days in 1973.

It is well recognized in the industry that shrimp trawlers have changed over the past decade. It is important then to consider this change as a factor affecting total fishing effort in the industry. To gain an understanding of the extent to which average fishing power of vessels has changed, a statistical analysis was made to relate the catch of an average vessel to various physical characteristics (gross tons, length, horsepower, size of nets, etc.)[2]. It was found that a combination of horsepower and net size was more significant in accounting for variation in catch. This is logical since these two factors together determine the amount of bottom that a trawler can cover in a given period of time. The results of this analysis are expressed as an effort index (Fig. 3). The effort index for vessel i is expressed as:

$$EI_i = \frac{HP_i^{0.1385}\, LFR_i^{0.4064}}{HP_S^{0.1385}\, LFR_S^{0.4064}}$$

where EI_i is the effort index for vessel i, HP_i is the horsepower rating for vessel i, LFR_i is the length of footrope as reported in NMFS data for vessel i, HP_S is the horsepower rating for standard vessel (arbitrarily selected smallest horsepower classification), and LFR_S is the length of footrope for standard vessel (arbitrarily selected smallest net size classification).

The average vessel which reported landings in 1963 had an index of 1.07 while in 1971 it had increased to 1.62 (a 51 percent increase). The estimate for 1962 is considered to be high due to the unusually poor catch that year. This change in the index means that the average vessel in 1971 exerted 51 percent more fishing effort for each day fished than the average vessel in 1963. The period 1963 through 1971 showed a generally steady upward trend. The projections for 1972 and 1973 are based on a straightline projection of the period 1963-1971. It is estimated that the average vessel effort index increased to a high of 1.8 units by 1973.

Notice up to this point that there has been a slowly increasing level of total days fished and a more rapidly increasing level of average vessel fishing power in the fleet. To get a true picture of the amount of total fishing effort being expended in the Gulf shrimp industry, these two factors must be considered together. A measure of total units of effort was derived by multiplying the effort index for each vessel by the total days fished

each year by that vessel and aggregating across all vessels in the fleet (Fig. 4). This measure of fishing effort is a significant improvement over days fished because it takes into account the ever increasing power of the vessels in the fleet. From 1963 to 1971 total fishing effort exerted by vessels in the Gulf shrimp fleet increased 65 percent from 149,640 effort units to 248,197. Again, the projection to 1973 shows a definite continuation of this trend to 305,000 effort units.

It is apparent from all evidence that fishing effort in the Gulf of Mexico shrimp fishery has increased over the last decade. However, a closer look at the trend in total effort reveals that nearly all of this has occurred since 1966. The increase from 1966 to 1973 is approximately 94 percent or a rate of 13 percent/yr.

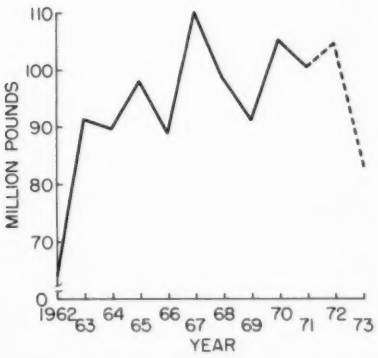

Figure 5.—Shrimp landings reported by vessels 5 GT and larger, heads-off weight, Gulf of Mexico, 1962-1973.

Catch

Shrimp landings by these same vessels (5 GT and larger) show a less clear trend than the effort statistics discussed above. The heads-off weight of the catch has varied from a low of 64.6 million lb in 1962 to a high of 110 million lb in 1967 (Fig. 5). The projection for 1973 reflects the poor landings that year. Ignoring the two poorest years, 1962 and 1973, it might be observed that there is slight upward trend in catch from 1963 to 1972. However, reviewing the longer trend in landings from the Gulf, this short term trend becomes less significant. Figure 6 shows the total landings of shrimp (boats and vessels) from the Gulf on a heads-on basis since 1890. In 1954 the record catch was made which has not been exceeded since. One interpretation of this graph is that a definite plateau has been reached in the Gulf of Mexico shrimp catch since the 1950's.

Catch/Unit of Effort

Having developed a series of data on both effort expended in the fishery and the associated landings, a measure of catch per unit of effort (CPUE) can be developed by simply dividing the total catch for each year (Fig. 5) by the corresponding total effort units (Fig. 4). The result is illustrated in Figure 7 which shows that the amount of shrimp caught for each unit of effort expended has generally declined over the last decade. Once again the observation derived for 1962 is discounted due to the unusual conditions of that year. Notice that all the decline in CPUE has occurred since 1967. By 1971 CPUE was only 67 percent of what it was only 4 yr earlier. The projection to 1973 indicates that CPUE has continued to decline. By 1973 the amount of shrimp landed for each unit of effort utilized in the industry had declined to less than one-half its 1967 level.

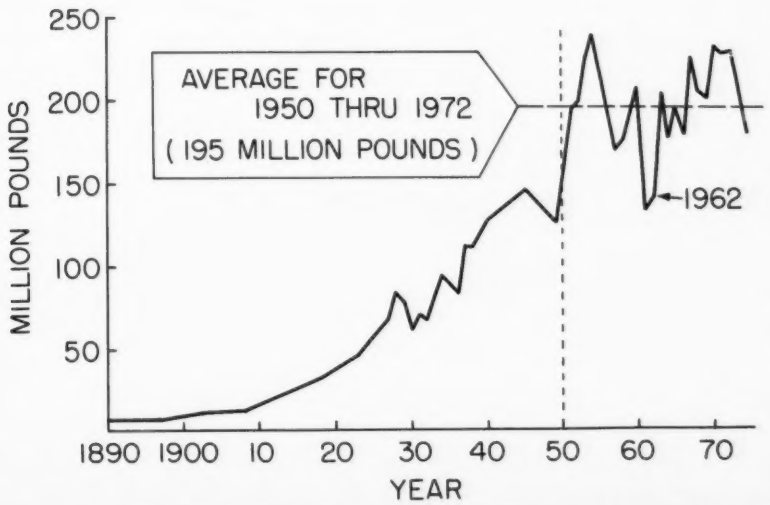

Figure 6.—Total shrimp landings (boats and vessels) heads-on weight, Gulf of Mexico, 1890-1973.

DISCUSSION AND IMPLICATIONS

It is at this point that the discussion must turn to the economic implications raised. If it could be assumed that the cost of producing a unit of effort in shrimp trawling has remained the same since 1967[3], then it could be concluded that the cost of landing 1 lb of shrimp in 1973 was nearly double that of 1967 since, on the average, CPUE declined 50 percent. If this is true, then how could shrimping operations have remained profitable during this period of time? The answer, of course, is that prices and gross revenues have increased dramatically since 1967. The trend in price is illustrated in Figure 8 where it is superimposed on the graph for CPUE. The clear picture is that since 1967, while CPUE has declined (and costs per unit caught increased), the ex-vessel price reported for these landings has risen significantly — 150 percent from 1967 to 1973. It is apparent that the high prices have drawn additional effort into the industry and that these same high prices through 1973 allowed these vessels to remain profitable on the average. Figure 9 illustrates another way of viewing this trend. Gross returns for these vessels (pounds landed × price) also shows an upward trend, though most of the increase occurred in the mid-1960's and again in 1969-1972.

It must be noted here that the major problem with extending this analysis in the economic realm is the lack of

[3]While this is a debatable point, possible economies gained through the use of larger vessels and nets probably have been offset by increased costs for inputs.

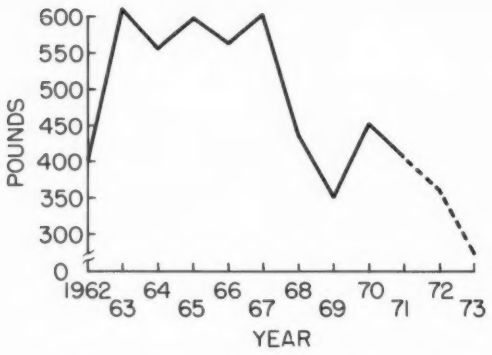

Figure 7.—Estimated catch per unit of fishing effort for the average vessel 5 GT and larger, Gulf of Mexico shrimp fishery, 1962-1973.

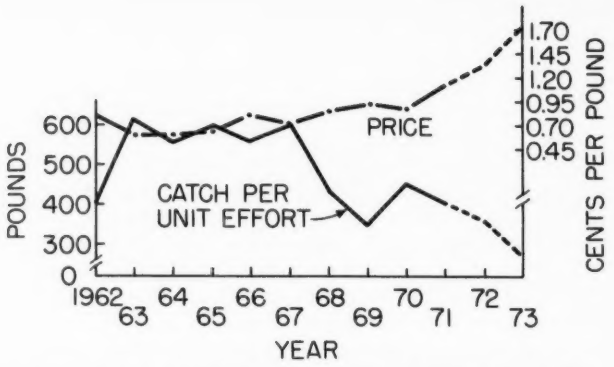

Figure 8.—Price and catch per unit of effort for shrimp landed by vessels, Gulf of Mexico, 1962-1973.

data on what really has happened to the cost structure in shrimp trawling since 1962. It was suggested above that perhaps the cost of landing shrimp doubled from 1967 to 1973 based on the assumption that the cost of producing a standard unit of effort remained unchanged during that time. The data to verify or refute this are simply not available. Only in the past year have studies been initiated specifically for the purpose of determining the cost structure for the shrimp trawling industry[4,5].

In a short-run analysis, the recent decline of prices in the Gulf shrimp fishery, combined with lower than expected landings through the summer of 1974, has created a great deal of financial strain on owners and operators. Much of the investment in additional vessels, which in the recent past was supported by high prices, is now vulnerable as prices have declined. At the same time operating costs (particularly fuel costs) have increased dramatically, causing additional problems. If returns are not sufficient to cover variable costs the rational vessel owner will discontinue active fishing operations until industry conditions improve. This does not, however, solve the problems of covering fixed costs and making regular payments to mortgage holders on many of the vessels. The main point which can be inferred from this analysis is that the real impact of the large increase in effort in the shrimp industry over the past 5 yr will be felt most severely now that prices have declined from the record high levels of 1973. The exact magnitude of this effect in economic terms cannot be measured until an improved data base on costs of owning and operating shrimp vessels is obtained. With these additional resources, management guidelines can be established for both private firms in the industry and policy makers in the many public agencies concerned with fishery resources.

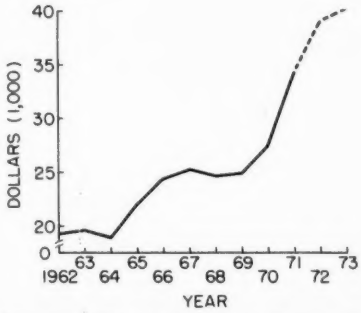

Figure 9.—Estimated average annual gross revenue for vessels, Gulf of Mexico shrimp fishery, 1962-1973.

[4]Lacewell, R.D., W.L. Griffin, J.E. Smith, and W.A. Hayenga. 1974. Estimated Costs and Returns for Gulf of Mexico Shrimp Vessels: 1971. Departmental Technical Report Number 74-1. Department of Agricultural Economics, Texas Agricultural Experiment Station, Texas A&M University, College Station, TX 77840.

[5]Research is also underway at Texas A&M University to establish costs for 1973 and a reporting system for subsequent years.

MFR Paper 1119. From Marine Fisheries Review, *Vol. 37, No. 2, February 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1120

Expansion has marked the new skipjack tuna fishery of Papua New Guinea.

Skipjack Tuna Fishing in Papua New Guinea, 1970-73

R. E. KEARNEY

INTRODUCTION

The live bait and pole fishery for skipjack tuna (*Katsuwonus pelamis*) in the southwestern Pacific Ocean has in recent years been one of the world's most rapidly expanding pelagic fisheries[1]. Expansion of this fishery has been most marked in the waters surrounding Papua New Guinea where, although prior to 1970 there was no commercial exploitation of the species, the catch landed by locally-registered pole vessels in 1973 was approximately 28,300 metric tons (mt).

Papua New Guinea has little history of skipjack fishing and the lack of suitable, locally-owned vessels meant that foreign fishing companies were required to survey the resources and commence commercial exploitation of existing stocks. Since the commencement of survey fishing the number of joint venture companies has risen to four and expansion of the total fleet continues; the annual catch has exceeded that of the preceding year in three of the four years of fishing, 1972 being the exception. As almost the entire catch has been taken by live bait and pole vessels the bait fishery has assumed great importance.

[1]See also "Japan's Skipjack Fishery Develops in South Pacific," Foreign Fishery Developments, page 42, this issue.

THE COMPANIES AND VESSELS

In March 1970 Gollin Kyokuyo (Niugini) Pty. Ltd., a joint Japanese-Australian company (Table 1) commenced survey fishing for skipjack in Papua New Guinea using the port of Kavieng as its home base. During 1970 only the single company was operating and the fleet consisted of a single mother ship and a maximum of four catcher boats in the 18- to 21-m class. Since the beginning of 1971 three additional companies (Table 1) have commenced fishing based in the ports of Rabaul and Madang and the number of catcher boats reached a high of 33 in June 1973. All operations to date have been based on the use of motherships: none of the companies relies on unloading fish at a permanent shore-based installation although company A does unload some fish to the katsuobushi plant at Kavieng.

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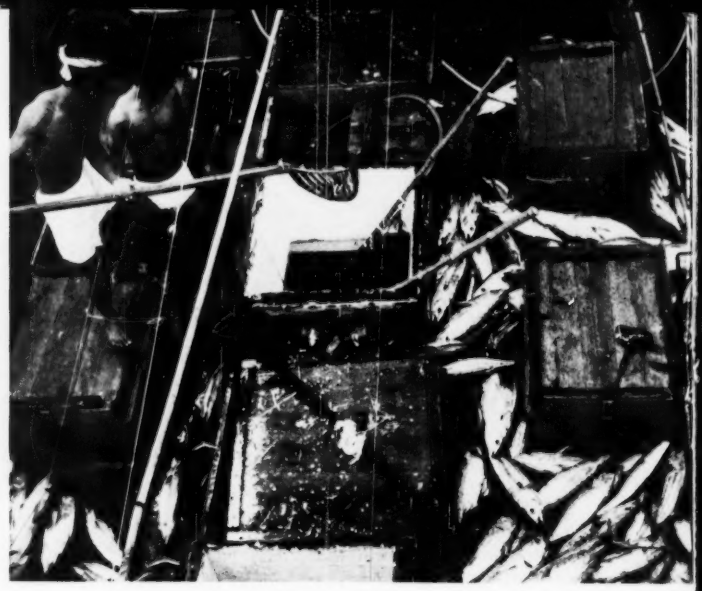
Table 1.—Composition of the four companies fishing for skipjack tuna in Papua New Guinea to the end of 1973.

Company	Percent composition[1]
(A) Gollin Kyokuyo (Niugini) Pty. Ltd.	55.0 Kyokuyo Co. Ltd. 45.0 Gollin Investment Pty. Ltd.
(B) Carpenter Kaigai (Papua New Guinea) Pty. Ltd.	75.0 Kaigai Gyogyo K.K. 25.0 W.R. Carpenter (P.N.G.) Ltd.
(C) New Guinea Marine Products Pty. Ltd.	44.5 Hokuku Marine Products Co. Ltd. 33.3 Nippon Suisan Kaisha Ltd. 22.2 C. Itoh and Co. Ltd.
(D) Star-Kist Papua New Guinea Pty. Ltd.	100.0 Star-Kist Food Incorporated (California)

[1]Under the terms of the fishing agreements signed with each of the companies the Papua New Guinea Government reserves the right to take up a 20 percent equity in each company.

Figure 1.—A skipjack catcher boat typical of those used in Papua New Guinea. Photo courtesy of the Department of Information and Extension Services, Papua New Guinea.



Scenes of skipjack and skipjack fishing out of Papua New Guinea. Photos courtesy of the Department of Information and Extension Services, Papua New Guinea.

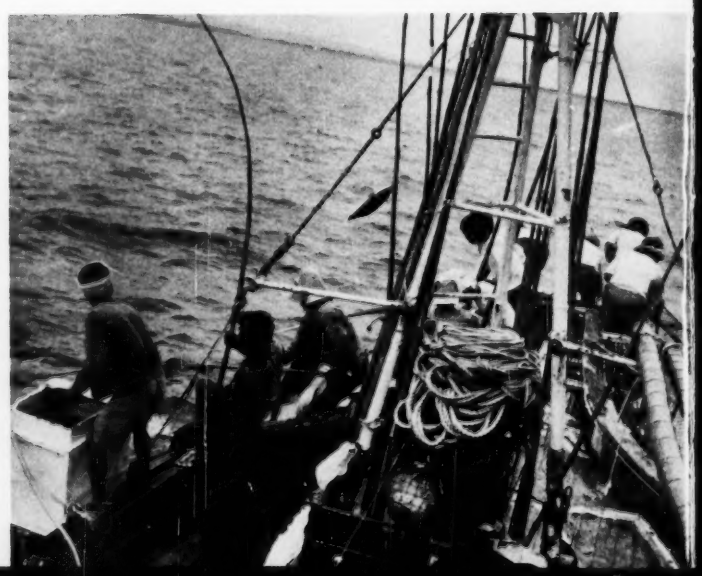


Table 2.—Positions of the exclusive bait fishing zones of each company.

Company	Exclusive Bait Fishing Area(s)
A	20 mile radius from S 02°17′48″ E 150°28′36″
B	20 mile radius from S 04°15′13″ E 151°46′03″
C	10 mile radius from S 05°10′0″ E 145°50′0″ and
	10 mile radius from S 05°33′30″ E 149°14′30″
D	10 mile radius from S 05°25′0″ E 150°06′0″ and
	10 mile radius from S 05°21′30″ E 150°54′0″

The fishing effort of each of the four companies has been generally concentrated within a 90-mile radius of the six restricted baitfishing areas (see under Bait Fishery). The localities of the major fishing areas can be approximated since 80.2 percent of the fish have been realized from bait caught in areas A and B (Table 2).

Since fishing commenced in 1970, 63 different live bait and pole boats have been registered for some period in Papua New Guinea. Of these, 60 were the common Japanese-type live bait and pole vessels (Fig. 1) of various sizes, two were Australian vessels normally employed in the southern bluefin tuna (*Thunnus macovii*) fishery off the southern coast of Australia and one was an American skipjack and yellowfin pole boat from California. Vessels of the Japanese design proved to be by far the most successful with those in the 21- to 28-m class being the most economical. The Japanese-designed vessels are crewed in the main by Okinawan fishermen but the number of Papua New Guineans in the crews, while still small, is increasing.

A single Japanese purse-seine vessel of 46.3 m fished in Papua New Guinea waters from November 1972 until the end of February 1973 and took a total of 335 tons of fish, of which 76 tons were skipjack (the remainder was mainly yellowfin (*T. albacares*) and bigeye (*T. obesus*) tuna). Admittedly, for a boat of this type this catch was small but bearing in mind that the catch by pole boats was abnormally low during this period further experimentation with purse seining in the western equatorial Pacific is definitely warranted.

THE CATCH

In order to maintain uniformity in the data, catches by the single purse seine and longline vessels have not been included in Table 3. All figures given in this table are taken from the daily catch returns completed by the various fishing companies.

Although skipjack is the target species for live bait and pole fishing and represents the greater proportion of the catch (Table 3), several thousand metric tons of juvenile yellowfin tuna have been taken since fishing commenced. The actual percentage of the catch which was yellowfin tuna has varied considerably from year to year, with 1972 (the worst year for skipjack) being unusually high. During 1970 when only one company was in operation catches appear to have been accurately declared according to species; however, since 1971 inaccurate declarations of the species composition of the catch on the part of one company have meant that estimates based on the figures for total catch and percentage composition of the catch recorded by the other companies have had to be made. Estimates on an annual basis are given in Table 3. Small quantities of black skipjack (*Euthynnus affinis*) and frigate mackerel (*Auxis thazard*) have also been taken but these have not been sufficient to warrant separate analysis. Black skipjack and frigate mackerel represent almost 100 percent of the "other species" category in Table 3 but the combined catches of both species did not exceed 300 mt in any one year.

None of the catch taken by joint venture fishing has been sold for consumption as fresh fish in Papua New Guinea; the greater part has been exported in the frozen round as outlined in Table 4. An estimated 3.3 percent of the catch prior to June 1973 was processed in the katsuobushi plant at Kavieng and then exported to Japan. This estimate was arrived at using the factory manager's assertion that the weight of katsuobushi produced by the plant was 20 percent of the weight of whole skipjack processed.

The total catch to the end of April 1973 was 34,777 mt, and that actually exported to the end of May of the same year was 33,779. This difference of almost 1,000 mt could be accounted for by the quantity of fish held on motherships awaiting export and the amount attributed to freezer loss.

While the katsuobushi plant at Kavieng is the only skipjack processing plant in operation in Papua New Guinea at present, a substantial canning complex was planned for construction commencing in 1974. In the

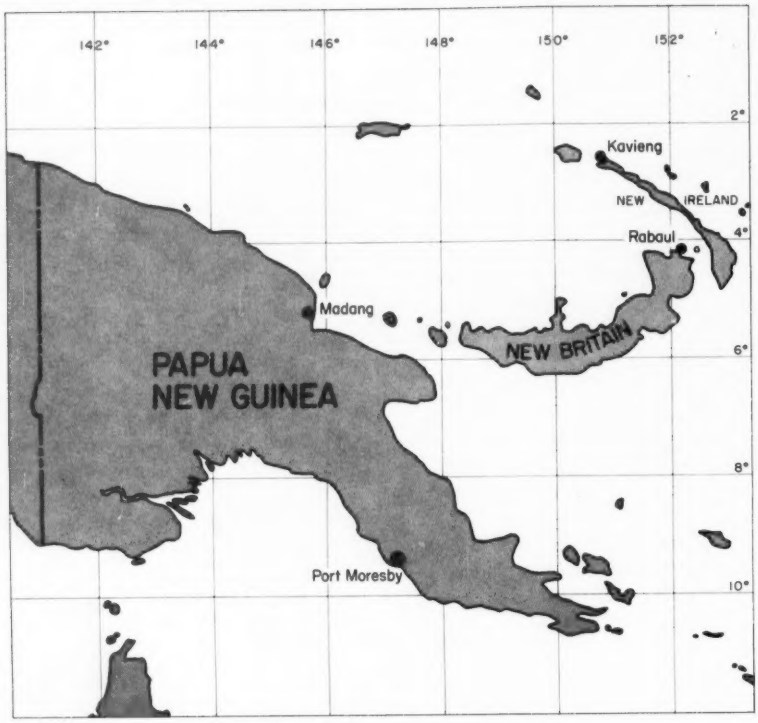
Table 3.—Annual catch and species composition of landing by live bait and pole boats in Papua New Guinea to the end of 1973. All figures are in metric tons.

	1970		1971		1972		1973	
	Total	Avg/Boat Day	Total	Avg/Boat Day	Total	Avg/Boat Day	Total	Avg/Boat Day
Jan	—	—	918	3.54	681	1.75	411	1.13
Feb	—	—	992	3.49	744	2.09	294	1.02
Mar	307	3.74	1,461	4.40	1,359	2.69	678	1.66
Apr	348	4.70	1,512	4.27	966	2.51	839	1.48
May	370	4.51	1,884	5.51	1,633	2.78	2,906	3.58
Jun	441	5.44	2,039	6.43	793	1.69	3,011	3.67
Jul	480	6.40	1,952	5.52	846	2.17	4,038	4.50
Aug	113	4.03	2,027	4.23	748	2.24	4,373	4.70
Sep	—	—	1,490	3.55	345	1.36	4,719	5.26
Oct	—	—	1,065	3.78	1,336	3.42	1,782	2.85
Nov	145	4.54	962	2.86	2,243	5.11	2,571	4.53
Dec	226	3.97	700	2.33	1,430	3.44	2,647	5.14
Total	2,430	4.76	17,002	4.19	13,124	2.67	28,269	3.68
Percent skipjack	96.8		99.0		86.5		94.4	
Percent yellowfin	3.1		0.8		12.5		4.6	
Percent other Species	0.1		0.2		1.0		1.0	

Table 4.—Disposal of catch by country of destination to the end of May 1973 (all figures are in metric tons).

	1970-71	1971-72	1972-73 (May)	Percentage of total
Japan	8,998.4	12,376.6	7,439.5	85.31
United States	—	1,821.5	470.9	6.79
American Samoa	—	272.3	1,271.0	4.56
Australia	2.3	—	—	0.01
Processed in Papua New Guinea[1]	—	679.1	448.0	3.33
Total	9,000.7	15,149.5	9,629.4	100

[1]This fish was processed in the katsuobushi plant at Kavieng and then exported to Japan. All figures for the quantities processed by this plant are based on a 20 percent return on fresh fish.



Papua New Guinea, showing areas mentioned in the text.

latter part of 1972 all four joint venture fishing companies agreed to the formation of the Papua New Guinea Canning Company, which is a consortium of the four companies. A report of a feasibility study carried out by the Canning Company is at present (September 1974) being considered but Government approval has already been given for the establishment of a fish canning complex at Madang. The size and proposed daily output of the cannery have not yet been established but under the terms of the original fisheries agreements each of the companies has agreed that 50 percent of the catch should be "processed" in Papua New Guinea by the end of 1977. The remainder of the catch will continue to be exported in the frozen round.

THE BAIT FISHERY

Initially in their baitfish surveys the pioneer companies used "drive-in" techniques and daylight baiting operations. In May 1971 the potential for attracting suitable baitfish to bright lights was realized and since this time all pole boats registered in Papua New Guinea have relied exclusively on night baiting with underwater lights and stick-held dip nets.

While some bait has been found in almost all harbors and anchorages on the periphery of the fishing areas, there is only a limited number of locations in which sufficient bait can be taken to regularly supply a fleet of the size operated by the joint venture companies. The best baitfishing areas investigated to date are those currently being fished by companies A and B (Table 2); however, areas which will support one or two catcher boats are very numerous.

Stolephorus anchovies have proven to be the most abundant bait species, but while they are excellent for attracting skipjack when broadcast from a boat, their value as a baitfish is restricted to some extent by their poor keeping qualities when being transferred into, and held in bait tanks in the catcher vessels. The fragility of the most common bait species means that baiting operations must be carried out each night. This coupled with the lack of refrigeration on most catcher boats has limited the range of most vessels to within approximately 60 miles of the baiting grounds. Each fleet has one or two larger refrigerated vessels which occasionally venture farther afield. Using the argument that overexploitation of existing bait resources was possible, each of the four fishing companies has applied for, and been granted, an area (20 mile radius) of coastline for its exclusive use as a baitfishing zone (Table 2).

While there have been times when sufficient bait could not be obtained (particularly during periods of full moon) and the lack of an abundant, hardy bait species hampered long range operations, all companies agree that the general availability of bait has normally been adequate for their needs. In so far as the experience gained in three years enables a prediction, it would appear that the known baitfishing grounds are in no immediate danger of being overfished and there are numerous other areas which could be developed as at least supplementary sources of bait. Indeed the bait resources should be sufficient to support considerable expansion of the live bait and pole fishery.

POSSIBLE FUTURE DEVELOPMENT

In three of the four years of skipjack fishing in Papua New Guinea the catches have been more than adequate to support a sizeable industry. Even though 1972 was a comparatively poor year, the future of the industry appears assured; the years 1970, 1971, and 1973 all saw catches well above the minimum limits for economic operation. It is anticipated that a better understanding of the seasonal migratory patterns of skipjack, coupled with improved techniques for bait capture and handling, will result in more consistent, and increased, catches in future years. The establishment of a sizeable canning complex at Madang will alter the present situation where more than 90 percent of the catch is exported in the frozen round.

MFR Paper 1120. From Marine Fisheries Review, *Vol. 37, No. 2, February 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1121

Sophisticated electronic devices are providing new data on salmonid biology and migration.

Electronic Tags and Related Tracking Techniques Aid in Study of Migrating Salmon and Steelhead Trout in the Columbia River Basin

GERALD E. MONAN, JAMES H. JOHNSON, and GORDON F. ESTERBERG

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ABSTRACT—Electronic tags for salmon have, since 1956, become more compact, reliable, and versatile. They are facilitating the study of migrating adult Pacific salmon, Oncorhynchus *spp., and steelhead trout,* Salmo gairdneri, *throughout the Columbia River Basin. By using sonic and radio tags and fixed and mobile monitoring devices, NMFS scientists have been able to locate the mainstream spawning areas of the fish, temperature blocks, and migration routes through reservoirs. Sonic and radio tags have also been used to study fish activities at and between dams in relation to modification of fishways, power-peaking operations, modified spillway flows, and passage conditions.*

INTRODUCTION

In 1956, two biologists of the National Marine Fisheries Service (NMFS)[1] released an adult coho salmon, *Oncorhynchus kisutch*, carrying a bulky electronic backpack into the watery backyard of the Northwest Fisheries Center (NWFC), Seattle, Wash. The pack was a 132 kHz, high-frequency sound transmitter (Trefethen, 1956). Homing-in on the transmitted signals with a directional hydrophone and receiver, the biologist planned to follow the movements of the tagged salmon throughout Lake Union. This early attempt at sonic tracking of salmon resulted in a track of slightly over 1 h and covered only a few hundred yards, but the results were encouraging enough that development continued on this technique for electronic surveillance of fish activities.

From 1956 to 1970, the sonic fish tag was refined and improved until an extremely reliable and useful tool was developed for studying problems related to passage of adult fish in the Columbia River Basin. The tags progressed from rather bulky units attached to the fish's back to compact, thumb-size capsules placed in the fish's stomach (Fig. 1). Exact tag specifications vary depending on intended use. Our current standard 50 kHz tag is a cylinder, approximately 2.5 inches long by 0.75 inch in diameter and weighing about 1 oz in water. A schematic diagram of the electronic components that make up the tag is shown in Figure 2. Acoustic output of the tag is 60 db re 1 microbar at 1 yard in fresh water. The tags are pulsed and the pulse rate can be varied to provide a variety of tag codes. This tag configuration provides an effective tracking range of up to 1 mile and battery life of about 10 days. Battery life can be increased by reducing the acoustic output, adding additional batteries, or changing the pulse rate and duration. Battery life up to several weeks is possible within the restraints of a reasonable tag size. In addition to the simple location devices, there are sonic tags that telemeter data about the fish's environment, such as temperature (Fig. 3). Sonic tags work effectively in fresh and salt water as long as the water is not highly turbulent and aerated.

In recent years, a radiofrequency fish tag was developed to be used in areas where attenuation of sonic tag

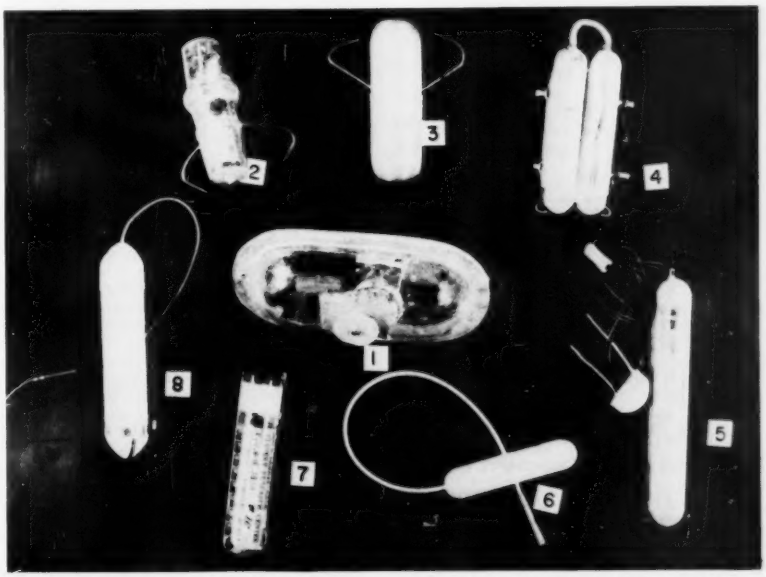
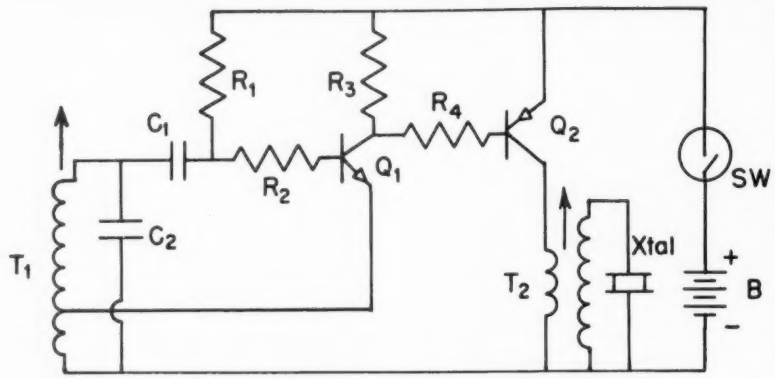


Figure 1.—Electronic tags: (1) first sonic tag; (2, 3) early model external sonic tags; (4) twin backpack sonic tag; (5) sonic tag (crystal fastened on fish's snout); (6) temperature sensitive sonic tag; (7) current model internal sonic tag; (8) radio tag.

[1]Known in 1956 as the Bureau of Commercial Fisheries (BCF), this agency was renamed in 1970 when transferred into the newly established National Oceanic and Atmospheric Administration (NOAA).



C_1 = 0.68 mfd. tantalum capacitor
C_2 = 0.0082 mfd. polyester film capacitor
R_1 = 3.6 Meg ohms, 1/8 watt resistor
R_2 = 1.2k ohms, 1/8 watt resistor
R_3 = 3.3k ohms, 1/8 watt resistor
R_4 = 3.3k ohms, 1/8 watt resistor
Q_1 = 2N2925 transistor
Q_2 = 2N3702 transistor

T_1 = 350 turns # 40 wire, center tapped, wound on a 3/16" form, and tuned with an 8-32 ferrite slug.

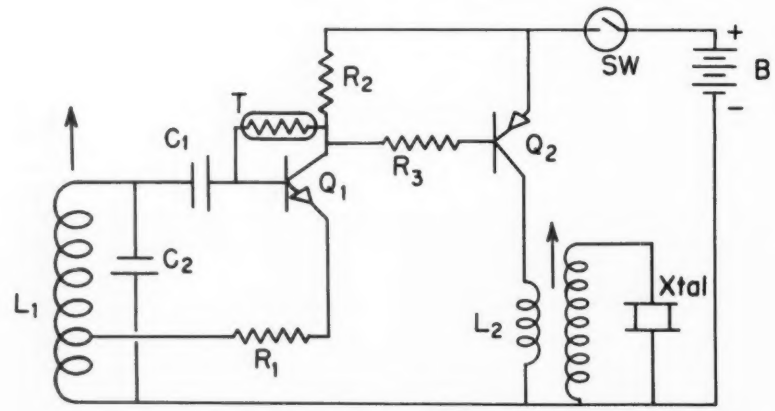
T_2 = Primary - 40 turns # 32 wire, Secondary - 700 turns # 36 wire, wound on a 3/16" form and tuned with an 8-32 ferrite slug.

Xtal = .50 kHz piezo-ceramic cylinder 0.695"OD x 0.485"ID x 0.5"H, material EC64.

SW = Magnetic reed switch.

B = 11.2V., 350 M.A.H. mercury battery.

Figure 2.—Schematic for a 50 kHz sonic tag.



C_1 = .022 mfd. polyester film capacitor
C_2 = .0047 mfd. polyester film capacitor
R_1 = 220 ohm, 1/8 watt resistor
R_2 = 1 k ohm, 1/8 watt resistor
R_3 = 2.2 k ohms, 1/8 watt resistor
Q_1 = 2N2925 transistor
Q_2 = 2N3702 transistor
T = Fenwal GA615MI thermistor

L_1 = 300 turns # 38 wire, CT, wound on a 3/8" length of soda straw and tuned with an 8-32 x 3/8" threaded slug.

L_2 = Primary - 35 turns # 36 wire, Secondary - 375 turns # 38 wire, wound on a 3/8" length of soda straw and tuned with an 8-32 x 3/8" threaded ferrite slug.

Xtal = 70kHz piezo-ceramic cylinder, 0.512"OD x 0.452"ID x 0.25"H, material EC64.

B = 7V., 160 M.A.H. mercury battery.

Figure 3.—Schematic for a 70 kHz sonic temperature tag (300 pps at 100°F, 50 pps at 32°F. Pulse length, 350 microseconds).

signals by entrained air and turbulence in the water made sonic tracking impossible. This radio tag is a battery powered, high-frequency radio transmitter that operates on a carrier frequency of approximately 30 kHz; with a 167 milliwatt input, it has an effective tracking range of 0.5 mile or more and an operational life of approximately 15 days. The tag is similar in size to a sonic tag and is carried in the stomach of the fish except for a small wire antenna that extends from the tag, through the fish's esophagus, to the roof of its mouth where it is attached with a plastic barb (Fig. 4). A schematic diagram of a typical radio tag is shown in Figure 5. The radio tag transmits efficiently through the turbulent waters below dams and can be tracked with mobile or fixed radio direction finders. Tags weigh about 1 oz in water and can be pulse-rate coded or frequency coded. Currently, the use of the radio tag is restricted to fresh water.

SONIC TRACKING

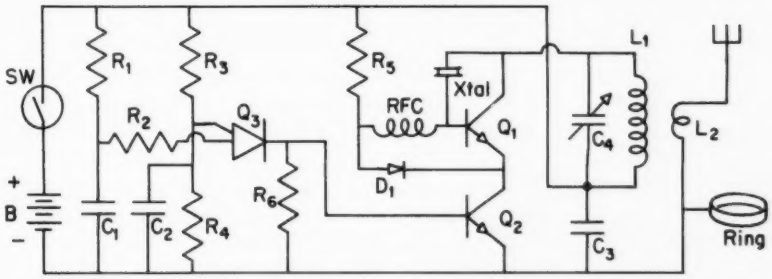
Sonic tracking is accomplished with a directional hydrophone placed in the water to pick up the signal from the tag. A sonic receiver receives the signal from the hydrophone and converts it to an audible tone. The operator then rotates the hydrophone and determines the direction of the loudest signal which indicates the direction of the tagged fish.

The sonic tracking system was first used in a full-scale biological study in 1957 at Bonneville Dam (Johnson, 1960). A total of 43 salmon and steelhead trout, *Salmo gairdneri*, were tagged and tracked as they exited into the forebay from the Washington-shore fishway. Fish were kept under surveillance with sonic receiving equipment in a small boat for as long as 16.75 h and tracked upstream as far as 10 miles. The study produced the first detailed information on individual fish behavior in the immediate vicinity of a major Columbia River Dam and showed migration patterns of adult salmon and trout exiting from a fishway. It also proved the worth of sonic tags and tracking for surveillance of fish activities. Further studies and improvements in the system followed.

Shore Monitors Used

In 1961-62, adult salmon passage was studied in Brownlee Reservoir (57.5 miles long) on the Snake River (Trefethen and Sutherland, 1968).

Figure 4.—Radio tag insertion into stomach of adult chinook salmon.



C_1 = 0.27 mfd. tantalum capacitor
C_2 = 0.001 mfd. polyester film capacitor
C_3 = 0.01 mfd. polyester film capacitor
C_4 = 15-60 mmfd. ceramic trimmer capacitor
R_1 = 1.8 Meg ohms, 1/8 watt resistor
R_2 = 43 k ohms, 1/8 watt resistor
R_3 = 100 k ohms, 1/8 watt resistor
R_4 = 150 k ohms, 1/8 watt resistor
R_5 = 47 k ohms, 1/8 watt resistor
R_6 = 100 k ohms, 1/8 watt resistor
D_1 = 1N457 diode
Q_1 = 2N2222 transistor
Q_2 = 2N2925 transistor
Q_3 = P13T1 transistor

L_1 = 12 turns #24 wire, rectangular air wound 3/16"H x 3/8"W x 9/32"L.
L_2 = 3 turns #32 wire wound on L_1 near middle of the coil.
Xtal = Quartz crystal, 3rd O.T., series, Freq. tol-.0025% at 68°F, ESR-60 ohms max, SM-1 holder.
SW = Magnetic reed switch.
Ring = Stainless steel band 1/8" wide x 0.003" thick, cemented to outside of capsule.
B = 11.2V., 350 M.A.H. mercury battery.
RFC = 75 turns #4 wire wound on a 22 Meg, 1/8 watt resistor.

Figure 5.—Schematic for a 30 Mhz radio tag (pulse rate: 1 pps; pulse length: 25 milliseconds).

Tracking of individual sonic-tagged fish provided detailed information on the movements of fish through this long, deep reservoir where there is little water current to provide orientation (Fig. 6). This study marked the first use of unmanned, fixed monitors placed at specific points along the shoreline to automatically record the date, time, and direction of travel of sonic-tagged fish on time-event charts. Although some fish were delayed, they were able to pass through the reservoir and on upstream to spawning areas.

Sonic-tagged fish and fixed monitors were used in 1963 at Ice Harbor Dam on the Snake River to determine the proportion of adult migrants that fall back downstream over the spillway after they exit from the fishways (Fig. 7). Hydrophones placed near

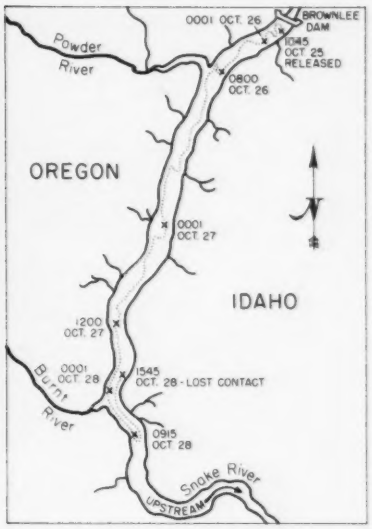


Figure 6.—Course of salmon tracked 77 h in Brownlee Reservoir. Drawing is diagrammatic; width of reservoir is not to scale. Fish traveled approximately 50 miles upstream before turning back.

the spillgates detected sonic signals and fed them to receiver-amplifiers; the amplified tag signals were automatically recorded on multichannel recorders to provide a record of fish that fell back through the spillway gates. Data from 223 tagged salmon indicated that 6.3 percent of the spring[2] chinook salmon, *O. tshawytscha*, migrating past Ice Harbor Dam fell back over the spillway during the study period. About 50 percent of the sonic tagged fish that fell back survived the experience and reascended the dam.

Spawning activity of fall chinook salmon in the area to be flooded by John Day Dam on the Columbia River was surveyed by a sonic tracking team in 1965 as part of a joint study with the Fish Commission of Oregon. In this study, 213 fall chinook salmon —judged by skin color to be at different stages of maturation—were tagged with coded sonic tags and released at The Dalles Dam, 24 miles downstream from the John Day Dam site. Fixed monitors located on the river banks recorded turnoff of tagged fish into two main tributaries—the Deschutes and John Day Rivers. To identify mainstem spawning areas,

[2]Seasonal races of chinook salmon in the Columbia River system are classified as spring, summer, or fall chinook depending on the time of year that the adults enter the river to spawn.

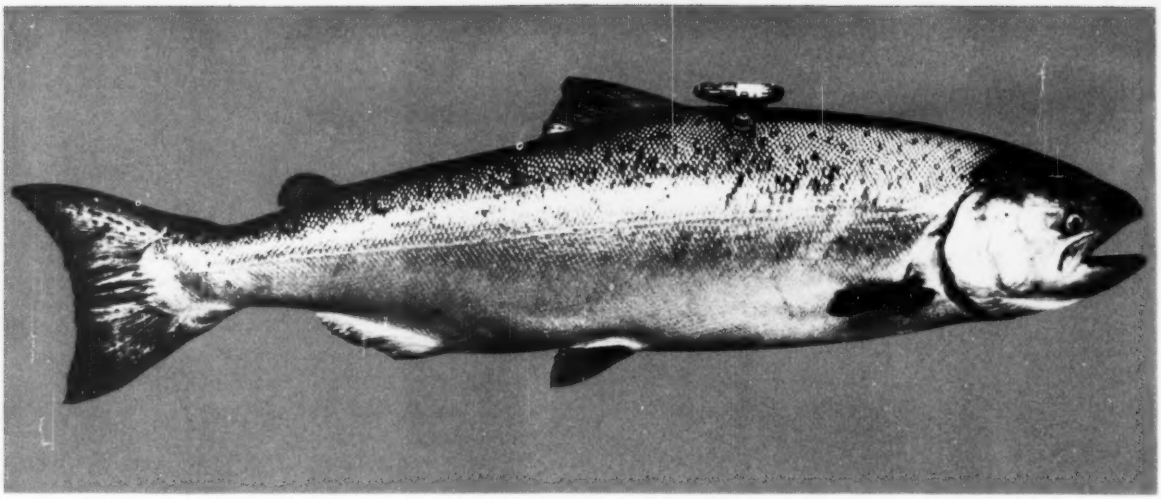


Figure 7.—Chinook salmon tagged with early model sonic tag.

Figure 8.—Sonic tracking crew in action.

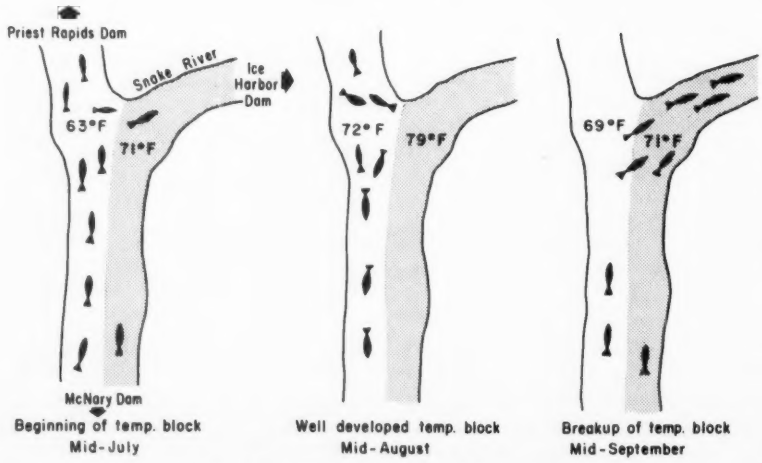


Figure 9.—Temperature block in the Snake River.

weekly surveys of the study area were made and the locations and codes of sonic-tagged fish charted (Fig. 8).

Temperature Block Located

Dramatic evidence of a severe temperature block at the mouth of the Snake River was obtained in 1967 from tracking 251 adult steelhead trout in McNary Reservoir (Snyder and Blahm, 1971) during their upstream migration (Fig. 9). In late July when river temperatures in the Snake River were near 75°F and the Columbia River was 9 degrees cooler, sonic-tagged fish began to concentrate at the confluence of the two rivers. During the temperature block, sonic-tagged fish remained in the cooler Columbia River water. In mid-September, when Snake and Columbia River water temperatures were near 70°F, large numbers of fish began moving up the Snake River. At the time of the temperature block, it was obvious from comparing fish counts at McNary, Ice Harbor, and Priest Rapids Dams that a holdup in fish passage was occurring, but through the use of sonic tags, biologists were able to pinpoint its location.

Scientific Assist To Angling

In 1969, sonic tracking provided a scientific assist to recreational fisheries in Ice Harbor Reservoir where steelhead fishermen were concerned over

flooding of their accustomed fishing areas by the large impoundments behind the dams in the Snake River[3]. A cooperative program was developed by the U.S. Army Corps of Engineers and NMFS. Adult steelhead trout were trapped at Ice Harbor Dam, tagged with sonic tags, released into the reservoir, and tracked as they moved upstream. Data indicated the fish followed specific migration routes through the reservoir and used certain areas for milling and resting. Information obtained by NMFS scientists was given to the Corps, which published maps showing migration and milling areas. Tri-State Steelheaders, Inc. (TSI) and the Washington Department of Game (WDG) organized "Operation Slackwater"—a mass fishing effort to develop fishing techniques to catch steelhead in the large reservoir. Based upon the angling success of fishermen armed with data from the tracking study, it was concluded that a sport fishery for steelhead in slackwater reservoirs is possible. The study is a good example of how cooperation of Federal, State, and private organizations can work toward resolution of a problem.

Telemetry Tag Developed

Temperature-sensitive sonic tags, developed by NWFC staff members, were used in a field study for the first time in 1970. In a study made jointly with Battelle Northwest, eight fall chinook salmon tagged with temperature-sensitive sonic tags were tracked in the Columbia River near the nuclear reactors of the Atomic Energy Commission at Hanford, Wash. The study demonstrated the usefulness of the tag, but not enough fish were observed moving past a reactor outfall to provide significant data.

RADIO TRACKING

When a radio-tagged fish comes into the study area, its position is usually monitored by two or more trackers. The direction-finder receivers used by the trackers are self-contained, battery-operated units that receive the radio signal from the antenna, amplify it, and convert it to an audible tone. The primary tracking antenna that receives the signal from the tag is a directional loop 18 inches in diameter. Tracking is usually done from fixed tracking stations located throughout the study area. By listening to the tag signal, rotating the loop antenna until a null point is reached, and then sighting along the geometric axis of the loop, the tracker can establish a bearing from the station to the tagged fish. If a second tracker is taking same action simultaneously, the two bearings can be plotted and the location of the fish established by triangulation.

In 1971, radio tags and tracking equipment were used in the first field test of our system to study behavior of adult spring chinook salmon as they approached Bonneville Dam. Radio-tagged fish were released approximately 5 miles downstream, and tracking teams stationed along the shoreline monitored the activities of the fish approaching the dam. The results showed that: (1) tracking radio-tagged fish in turbulent areas below a dam is a workable and useful approach to studying fish behavior—this solved the previously mentioned problem that we had with sonic tags in aerated water; (2) during periods of high river flow, fallback of salmon can contribute to inflation of fish counts at Bonneville Dam—32 percent fallback was estimated in spring of 1974; (3) closure of counting station gates causes excessive delay and should be kept to an absolute minimum; and (4) river flows in excess of 325,000 cfs impede upstream migration.

Mobile Tracking Unit Used

In 1972 a mobile radio-tracking vehicle was developed for a study in which observations were made on fish behavior at Bonneville and The Dalles Dams to compare behavior patterns of spring chinook salmon at the two dams and to determine problem areas relating to loss of spring chinook salmon between the two dams[4]. Radio tags were placed on 40 adult spring chinook salmon which were released at various locations above and below Bonneville Dam. Tracking teams located at each dam monitored fish behavior in the immediate vicinity of the dam and for the first time used the mobile tracking vehicle equipped with two-way radio communications and a radio direction finding unit along the highway between the dams to monitor the progress of tagged fish up the river (Fig. 10). The mobile unit also traveled along tributary streams to record the presence of tagged fish. Based on data from this study, it was concluded that: (1) spring chinook salmon spend more time passing over Bonneville than The Dalles Dam; (2) during certain river flows, fallback

[3]Monan, G. E., K. L. Liscom, and J. R. Smith. 1970. Final report—sonic tracking of adult steelhead in Ice Harbor Reservoir, 1969. Biological Laboratory, Bureau of Commercial Fisheries, USFWS, Seattle, Wash. 12 p. (Processed.)

[4]Monan, G. E. and K. L. Liscom. 1973. Final report—radio tracking of adult spring chinook salmon below Bonneville and The Dalles Dams, 1972. Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash. 37 p. (Processed.)

Figure 10.—Mobile tracking unit.

can be more of a problem at Bonneville than at The Dalles Dam; (3) a substantial percentage (95 percent) of spring chinook salmon that reach The Dalles area successfully pass over the dam; (4) unaccountable losses between dams (11 percent) were more likely to be associated with events at Bonneville Dam and in the river between dams than with events at The Dalles Dam; and (5) mortalities from dropouts from gill nets fished between the dams are a possible causative factor in the unaccountable losses.

Effects of Spillway Deflectors Studied

In 1973, radio tracking was used to study fish behavior in relation to flow from experimental flow deflectors at dams[5]. The flow deflectors were installed by the Corps of Engineers to control the levels of dissolved atmospheric gas below spillways by changing the direction of spill from plunging to horizontal. Studies were centered at Lower Monumental Dam on the Snake River, where two of the eight spillbays were modified with deflectors. Here 20 separately identifiable radio-tagged spring chinook salmon were released below the dam and their behavior monitored as they approached and passed over the dam (Fig. 11). To assure that a maximum number of tagged fish frequented the critical areas below the deflectors, spilling was restricted, as much as possible, to the bays containing the flow deflectors. Approximately 50 percent of the tagged fish were tracked into the areas of concern and none showed any signs of abnormal behavior after their experience. All tagged fish passing over the dam were observed at the viewing windows of the counting stations and no serious injuries were apparent. It was concluded that spring chinook salmon, swimming of their own volition into the area immediately below a spillway discharging water over a spillway deflector, do not suffer debilitating injuries when discharges through the bay are in the range of 2,800-9,800 cfs. Results of this study were instrumental in the planning for additional installation of spillway deflectors at Lower Monumental Dam and other dams within the Columbia River Basin.

[5]Monan, G. E. and K. L. Liscom. 1974. Final report—radio tracking of spring chinook salmon to determine effect of spillway deflectors on passage at Lower Monumental Dam, 1973. Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash. 20 p. (Processed.)

Peaking Studies

The year 1973 marked the first full-scale use of a Fish Tracking Control Center where the activities of nine separately identifiable radio-tagged fish were monitored at one time. Real-time plots were maintained on each fish based on bearings radioed in from trackers located at stations throughout the study area. The positions of the fish are recorded on large charts much as aircraft positions are plotted by air traffic controllers at an airport (Fig. 12).

Radio tracking studies, begun in 1973, entail examination of the effects of daily fluctuations in river flow on migration of adult salmonids. Changes in the production pattern of electrical energy in the Pacific Northwest will accelerate power peaking operations at mainstem dams on the Columbia and Snake Rivers; this will require higher river discharges to produce large amounts of electrical energy at dams when the demand for power is high (normally in the morning and early evening) and lower flows and storing of water when the demand is low. Fishery agencies are concerned that resulting fluctuations in river flow could adversely affect the migration and survival of adult salmon and trout in the Columbia River System. In the initial tracking study, 51 adult fall chinook salmon were tagged with radio tags and their behavior was ob-

Figure 11.—Manned radio tracking station at Lower Monumental Dam.

Figure 12.—Fish Tracking Control Center in operation at Lower Monumental Dam.

served in the vicinity of Bonneville Dam in August and September 1973. At the time, record low river flows resulted in a critical power shortage, which forced some departure from our original test plan of controlled peaking operations. Nevertheless, baseline data were obtained on fall chinook behavior under varying flow conditions.

WHAT ABOUT THE FUTURE?

Electronic surveillance of fish activities will continue to be an important means for studying upstream migrations in the Columbia River Basin and elsewhere. Tracking of sonic and radio tagged adult Pacific salmon and steelhead trout has already provided considerable insight into problems associated with passage conditions at and between dams, increased river water temperatures, and loss of fish and fishing due to dam construction throughout the Columbia River Basin. As additional demands are placed on use of our water resources (e.g., irrigation withdrawals and pumping of water for storage and use when needed at hydroelectric plants), further control of river flow and temperature regimes with corresponding new problems for anadromous fish may be expected. The effects of these manipulations on anadromous and resident fish will need to be determined in the very near future.

Equipment and techniques for sonic and radio tracking of adult salmon and steelhead have improved markedly since their inception in 1956. However, today's technology cannot be relied upon to answer all of tomorrow's questions, and scientists are alert to take advantage of all ways to improve tools and techniques that can provide many needed answers. On the horizon is a pressure sensitive tag to provide eagerly awaited information about migration depths for salmon and trout. Also under investigation is the possibility of automating the tracking process to obtain more and better data with less manpower. A major advance in battery design is needed to further miniaturize the tags to make them suitable for smaller species of fish and perhaps even juvenile salmonids. Fortunately, the field of bioelectronics is racing ahead and breakthroughs are frequent.

ACKNOWLEDGMENTS

In addition to the authors, the following scientists and technicians of the NWFC, NMFS, contributed to the development of the electronic tag and its use in the Columbia River Basin: Charles J. Bartlett, Gerald B. Collins, Richard L. Foust, John R. Hughes, Kenneth L. Liscom, Anthony J. Novotny, Jim R. Smith, Donald L. Thorne, Parker S. Trefethen, John C. VanDerwalker, and Charles D. Volz.

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MFR Paper 1121. From Marine Fisheries Review, *Vol. 37, No. 2, February 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1122

More than a million privately owned recreational boats ply U.S. seas.

Selected Information on Recreational Boats in the United States

JOHN RIDGELY

INTRODUCTION

Information on the number of recreational boats in the United States is available through various sources such as individual State numbering systems and the U.S. Coast Guard inspection system. However, the number of recreational boats that are privately owned for amusement or relaxation purposes, as opposed to such commercially owned vessels as party, head, and charter boats, has not been known. Also not known was how many recreational boats are used by saltwater anglers.

In 1973, the National Marine Fisheries Service contracted with a private company, Information Concepts, Inc.[1], to collect certain information on recreational boats in the United States. The results of this work included: (1) the number of private recreational boats and commercial recreational boats in the United States by State and size class, (2) the number of private recreational boats and commercial recreational boats that fish in saltwater areas over a 12-mo period by State and size class, (3) the number of fishing trips over a 12-mo period by State and size class, (4) the species of fish sought on each trip by area fished, and (5) an estimate of the annual gross revenues of commercial fishing boats by size class.

The private recreational boat survey results are based on telephone interviews with 10,068 households throughout the United States. These interviews reported 941 households with one or more privately owned recreational boats.

The commercial recreational boat survey results are based on 163 telephone interviews. This sample was obtained from charter boat membership lists, individual State fishing advertising brochures, and the classified section of telephone directories in areas of heavy commercial recreational fishing boat concentrations.

The household telephone survey indicated that there were some 8,008,000 privately owned recreational fishing boats in the United States as of October 1973. Some 1,010,000 of those boats were used in saltwater recreational fishing activities. The separate survey of U.S. Coast Guard records, combined with a telephone survey of known commercial recreational fishing boat owners conducted concurrently, indicated there were 2,496 commercial recreational fishing boats in the United States. A more detailed discussion of the survey methodology is presented after the results.

SURVEY RESULTS

Table 1 shows the estimated number of private recreational boats in the United States by region and size class as of October 1973. These numbers include all boats except kayaks, rafts, rubber dinghies, and similar floating craft. New England includes the States of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont; the Middle Atlantic includes New Jersey, New York, and Pennsylvania; the South Atlantic includes Delaware, District of Columbia, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia; the Gulf includes Alabama, Florida, Louisiana, Mississippi, and Texas; the Pacific area includes Alaska, California, Hawaii, Oregon, and Washington; and the inland area includes the rest of the States (Fig. 1).

Table 2 summarizes by size class and region the number of boats that were used in saltwater recreational fishing from November 1972 through October 1973.

Table 3 summarizes by size class the number of fishing trips and the number of days fished by the saltwater recreational boat owners. Since no significant difference in the number and length of trips taken by a given

Table 1.—Number (in thousands) of private recreational boats by size class and region, October 1973.

Region	Size class (ft)			Total (all classes)
	<16	16-26	≥26	
New England	223	157	29	409
Middle Atlantic	586	366	46	998
South Atlantic	519	208	24	751
Gulf	988	389	31	1,408
Pacific	602	348	57	1,007
Inland	2,432	951	52	3,435
Total	5,350	2,419	239	8,008

Table 2.—Number (in thousands) of private recreational boats that fished in salt water from November 1972 through October 1973 by size class and region.

Region	Size class (ft)			Total (all classes)
	<16	16-26	≥26	
New England	36	38	12	86
Middle Atlantic	86	93	30	209
South Atlantic	65	70	22	157
Gulf	190	141	18	349
Pacific	67	114	15	196
Inland	6	6	1	13
Total	450	[1]461	[1]99	1,010

[1]Numbers do not add to total because of rounding.

Table 3.—Number of trips and the corresponding number of days (in thousands) spent in different kinds of salt water by private recreational boats from November 1972 through October 1973 by size class.

Fishing effort	Size class (ft)		
	<16	16-26	≥26
Open ocean			
Boats	258	271	51
Fishing trips	3,016	4,771	582
Fishing days	3,030	5,524	783
Rivers, sounds, and bays			
Boats	309	307	67
Fishing trips	5,252	4,804	799
Fishing days	5,557	5,641	860

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[1]Mention of trade names does not imply commercial endorsement by the National Marine Fisheries Service, NOAA.

Figure 1.—Regional breakdown of states used in this survey.

size of boat between regions was found, the data are combined for all regions in this table.

The respondents were asked to name the species of fish sought on their fishing trips. Table 4 summarizes the most often mentioned species. Table 5 shows the estimated number of commercial recreational fishing boats in the United States as of October 1973. These numbers include those boats carrying at least one paying fisherman. Table 6 summarizes the number of fishing trips and the number of days fished by the saltwater commercial recreational fishing boats. Most commercial recreational fishing boats can and do fish in both open ocean and rivers, sounds, and bays; therefore, no distinction in numbers fishing in each area was attempted. Since no significant difference in the number and length of trips taken by a given size of boat between regions was found, the data are combined for all regions in this table.

The commercial recreational fishing boat captains were also asked to name the species of fish sought on their fishing trips. Table 7 summarizes the most often mentioned species. Table 8 summarizes the answers to the survey question "What was your gross revenue from commercial saltwater fishing over the past 12 months?"

SURVEY METHODOLOGY

Determining the number of recreational boats in the United States, and securing information on their use is arduous. It could be a relatively simple task with a uniform boat-licensing and usage system. However, a researcher seeking information on this subject is obliged to rely on State boat-licensing and boat-numbering records or on the U.S. Coast Guard records developed from its inspection system. These records do not supply adequate information to the researcher because (1) most States do not include boat usage in their boat-licensing systems, (2) there is no uniform commercial boat-licensing system for all States, and (3) the Coast Guard inspection system does not record any boat that carries less than seven passengers.

Table 4.—Major[1] species of fish sought by private recreational boaters on saltwater fishing trips from November 1972 through October 1973.

Region	Species sought	
	Open ocean	Rivers, sounds, and bays
New England	Bluefish Summer flounders Atlantic mackerels	Bluefish Striped bass Atlantic mackerels Summer flounders
Middle Atlantic	Bluefish Weakfish Summer flounders Lobster Mackerels Billfishes	Winter flounders Summer flounders Weakfish Bluefish Kingfishes
South Atlantic	Bluefish Summer flounders Croakers Spanish mackerels	Bluefish Basses Spotted seatrout
Gulf	Trouts Snook Groupers Red snapper	Spotted seatrout Red drum Snappers
Pacific	Chinook salmon Coho salmon Pink salmon Rockfishes Pacific halibut	Chinook salmon Coho salmon Crabs Pink salmon

[1]Most frequently mentioned species by order of frequency mentioned.

Table 5.—Estimated number of commercial saltwater recreational fishing vessels by region and size class, October 1973.

Region	Size class (ft)			Total (all classes)
	<40	40-65	≥65	
New England	135	220	20	375
Middle Atlantic	96	393	74	563
South Atlantic	50	234	14	298
Gulf	85	310	42	437
Pacific	183	590	50	823
Total	549	1,747	200	2,496

Table 6.—Estimated number of trips and the corresponding number of days spent in different kinds of salt water by commercial saltwater recreational fishing vessels from November 1972 through October 1973.

Fishing effort	Size class (ft)		
	<40	40-65	≥65
Boats	549	1,747	200
Open ocean			
Commercial fishing trips	58,702	211,282	51,267
Commercial fishing days	58,432	229,452	41,828
Rivers, sounds, and bays			
Commercial fishing trips	51,040	153,562	11,852
Commercial fishing days	50,054	151,063	12,852

Table 7.—Major[1] species of fish sought by commercial recreational boaters on saltwater fishing trips from November 1972 through October 1973.

Region	Species sought	
	Open ocean	Rivers, sounds, and bays
New England	Cods Bluefish Haddock Pollock Striped bass	Bluefish Striped bass Black sea basses Tunas
Middle Atlantic	Cods Bluefish Black sea basses	Black sea basses Bluefish Sharks Dolphins Tunas
South Atlantic	Bluefish Spanish mackerels Black sea basses King mackerels Dolphin	Bluefish Summer flounders Striped bass Black sea basses Spot
Gulf	Red snapper Snappers Groupers King mackerel Kingfishes	Red snapper Spotted seatrout Sand seatrout
Pacific	Bonitos Pacific basses Rockfishes Chinook salmon California yellowtail	Striped bass Sturgeon Salmons

[1]Most frequently mentioned by order of frequency mentioned.

Table 8.—Average annual gross revenue of commercial saltwater recreational fishing vessels by size class, from November 1972 through October 1973.

Size class (ft)	No. commercial recreational fishing vessels	Average annual gross revenue (in dollars)
<40	549	6,610
40-65	1,747	17,211
≥65	200	260,891

Since no licensing, registration, or other systematic identification program for recreational boat operators exists, special survey techniques had to be used to collect this information and assure that all recreational boat operators had a chance of being included in the sample. Three survey techniques were available: (1) personal interview, (2) mail questionnaire, and (3) telephone survey. The personal interview approach was rejected because the location of recreational boat operators in the general population is not known and most of the personal interviewer's time would have been spent traveling from house to house screening to find recreational boat operators rather than interviewing them. The cost per boat owner interview for such a project would have been so high that few owners could have been contacted.

The mail survey approach was rejected because the surveyor would lack control over the respondents to the questionnaire, with the possibility of a resulting nonresponse bias and inability to adjust for it.

The telephone survey was selected as the one that could produce the highest degree of coverage consistent with statistical validity for the funds available. The first phase located the scattered private recreational boat operators. The second phase interviewed the operators. Both jobs were done in a way that permitted expansion of survey results to population estimates. A random sample of households was contacted by telephone and asked whether or not any member of the household owned any type of boat. The assumption was made that the universe of telephone households includes the universe of boat owners or simply that the vast majority of boat owners have a telephone. Interviews were conducted with people who stated that they were recreational boat owners. The interviewer screened out obviously unqualified respondents: small children, those who were unduly imprecise in their answers, pranksters, etc. A specific advantage of this type of interview technique was that its low cost per interview allowed a statistically reliable sample of households to be contacted. Other advantages offered by the telephone survey approach were: (1) that information pertaining to commercial and noncommercial recreational boating was obtained within the allotted time constraints, (2) a reasonably complicated "branching" questionnaire tailored to the operator's boating experience was used, and (3) the interviewers were able to probe for more detailed information as necessary to resolve any major inconsistencies in responses.

A specified number of survey contacts were allocated to each sampling unit. The households were selected by random telephone numbers generated through the use of a computer. In this way, unlisted numbers had an equal chance of selection as a listed number. This procedure leads to a large number of nonhouseholds and nonworking numbers being contacted. In order to interview 10,068 households, 24,393 telephone numbers were dialed. Nonhousehold numbers accounted for 1,222 calls, there were 1,382 refusals, nonworking numbers accounted for 5,185 calls, and there was no answer or a busy signal for 6,536 calls.

The telephone was also used to conduct interviews with the commercial recreational boat owners. As is the case with the private sector, there are few States with any licensing requirements for commercial recreational boats or their crews. Therefore, a sample of commercial recreational boats was obtained from charter boat membership lists, individual State sport-fishing advertising brochures, and the classified section of telephone directories in areas of known heavy commercial recreational fishing boat operations. This data was then interfaced with records kept by the U.S. Coast Guard to estimate the number of similar boats in the United States.

The complete report which includes more detailed survey results, a complete discussion of the survey methods, and the survey questionnaire is available upon request from the National Technical Information Service. It may be ordered by sending $4.50 to: National Technical Information Service, U.S. Department of Commerce, Sills Building, Springfield, VA 22151. Request NTIS Accession Number COM-74-11186/AS. Checks or money orders can be made payable to the National Technical Information Service.

MFR Paper 1122. From Marine Fisheries Review, *Vol. 37, No. 2, February 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

MFR PAPER 1123

Edible Seaweeds — A Survey of the Industry and Prospects for Farming the Pacific Northwest

CHARLES J. HUNTER

Figure 1.—Sushi, a Japanese dish made from rice and other foods such as fish, vegetables, and seaweed. Note the nori in the upper left corner.

ABSTRACT — For centuries, seaweeds have been used by man throughout the world. They are presently used as food and as a source of chemicals. In Oriental communities, seaweeds are used primarily as food. The U.S. harvest is used mostly for the production of chemicals. Most edible seaweeds are imported from Japan and the Republic of Korea and retail at prices ranging from $2 to $56/lb. There is already an established market in the United States with opportunities for expansion. The availability of suitable growing conditions in Puget Sound, the presence of a large Oriental community, and the high prices commanded by seaweed products suggest that edible seaweeds can be grown and marketed successfully in the Puget Sound Basin.

INTRODUCTION

In China, the use of seaweeds was recorded as long ago as 3,000 B.C. Throughout the world, their use has continued through the ages although the Greeks and Romans had little regard for them. In Europe, as far back as the 12th Century, seaweeds were used as animal feed and fertilizer. During the 18th Century, seaweed ash was the main source of soda for making glass and soap. Burning kelp for soda thrived as an industry until it was discovered how to use salt as a more efficient source. The kelp industry then declined rapidly. Seaweeds have been used at times as sources of other chemicals, such as iodine, only to be replaced by other, cheaper sources as they became available.

Carrageenan, a gelling agent derived from Irish moss, *Chondrus crispus*, was first discovered in Ireland. Production in the United States began along the Atlantic coast about the middle of the 19th Century, expanded rapidly, and continues today.

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From 1911 to 1914 when imports of potash into the United States were greatly reduced, seaweeds were used as alternate sources. Surveys and subsequent harvests along the Pacific coast during this period showed that estimates of yield were overly optimistic (Scagel, 1961), a point to be considered in estimating potential production from wild stands.

Historically, the harvest of seaweeds in the Western world has varied with the demand for chemicals. Each time a cheaper, more convenient source was discovered, the seaweed market collapsed. Now seaweeds are used mostly for food, fertilizer, or as sources of agar, algin, and carrageenan. In the Orient, where seaweed is widely used as food, it is not a staple, but rather a seasoning and food supplement. In Oriental communities throughout the world, the demand for edible seaweeds is likely to increase as purchasing power and living standards rise.

In the United States, seaweeds are eaten primarily in Japanese communities located in large cities such as Los Angeles, Chicago, San Francisco, and Seattle. The sale of these seaweed products is expanding with the penetration of Japanese-type foods into gourmet markets. Most of the processed edible seaweeds are imported from Japan and are very expensive, retailing at up to $56.00/lb (net). However, home processing of seaweeds of good quality from the intertidal beaches is not uncommon among Japanese-Americans on the West Coast.

The three most common seaweeds used as food both here and in Japan are *Laminaria* (kombu), *Porphyra* (nori), and *Undaria* (wakame). Kombu

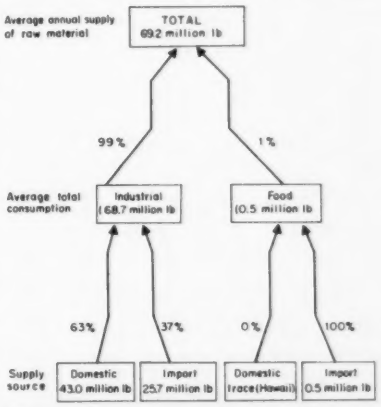

Figure 2.—Average annual supply and source of seaweeds (dry weight) in the United States, 1962-70.

is used as soup stock. Dried strips are eaten as snacks. Shredded and soaked in soy sauce, it serves as seasoning for rice dishes and is also boiled and eaten as a vegetable. Although taste is the main concern of those who eat seaweeds, the nutritional properties are likely to be beneficial (Taub, 1972). Kombu contains 6 percent protein, vitamins, and trace minerals (dry weight); nori (Japanese term for laver) contains 30-50 percent protein (dry weight) in addition to vitamins and minerals (Silverthorne and Sorensen, 1971). Analyses of several species of nori that grow in Puget Sound confirm this with similar ratios of protein (27 to 41 percent). Dried and pressed into sheets, nori is used to wrap rice rolls (Fig. 1) which are eaten by the Japanese somewhat as sandwiches are in the West. Small flakes of nori also flavor rice crackers, soups, and other dishes. Wakame is used as a vegetable in salads and soups.

In Japan, 65 percent of the wakame and almost all of the nori production comes from cultured stocks. In contrast, only about 30 percent of the kombu comes from cultured stocks.

Seaweeds, like other plants, contain carbohydrates, fats, and proteins. The carbohydrates are not very sweet and do not bring about a significant increase in blood sugar when eaten. The proteins, similar to those of land plants, are useful for human nutrition. Although they do not contain much fat, at least one unsaturated fatty acid necessary for human health is usually present along with vitamins (A, B-complex, and C) and minerals (sodium, iodine, and trace elements), which are important in human nutrition. Although synthetically iodized table salt is abundant and cheap, many people prefer natural combinations of these minerals as found in seaweeds.

In addition to the nutritive value of seaweeds, Dr. Stanley Skoryna, of the Gastro-Intestinal Laboratories of McGill University in Montreal, Canada, has found that sodium alginate from ingested seaweeds assists the selective absorption of calcium over strontium so that calcium is absorbed through the intestinal wall while 50-80 percent of the strontium (including the dangerous isotope Sr^{90}) is bound by the alginate and is harmlessly excreted (Taub, 1972).

Studies of mammary cancer in laboratory animals and humans show that the higher the level of iodine in the tissues, the lower the incidence of cancer (Eskin, 1970). Adding seaweed products to the diet is a simple, effective way to provide iodine therapy.

HARVEST AND MARKETS

World Production

In 1961 the worldwide harvest of seaweeds amounted to 1.2 million metric tons (mt), wet weight, and increased in 1970 to 1.7 million mt. Average annual increase for the period was 4.3 percent. Silverthorne and Sorensen (1971) estimated that Asia currently produces 72.3 percent of the total with the Peoples Republic of China producing 35.8 percent, Japan 29.5 percent, and the Republic of Korea 7.0 percent. The United States produces 7.5 percent of the total world harvest.

U.S. Production and Supply

In the United States, seaweeds are used mainly for the production of agar, algin, and carrageenan. In addition, some seaweeds are used for fertilizer and meal. The quantity, sources, and uses of seaweeds in the United States are shown in Figure 2.

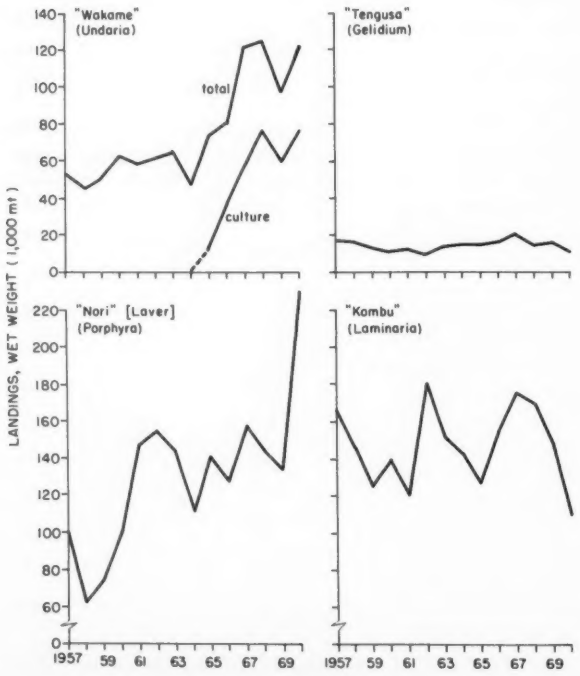

Figure 3.—Japanese production of edible seaweeds during 1957-70. Source: Ministry of Agriculture and Forestry, 1972a.

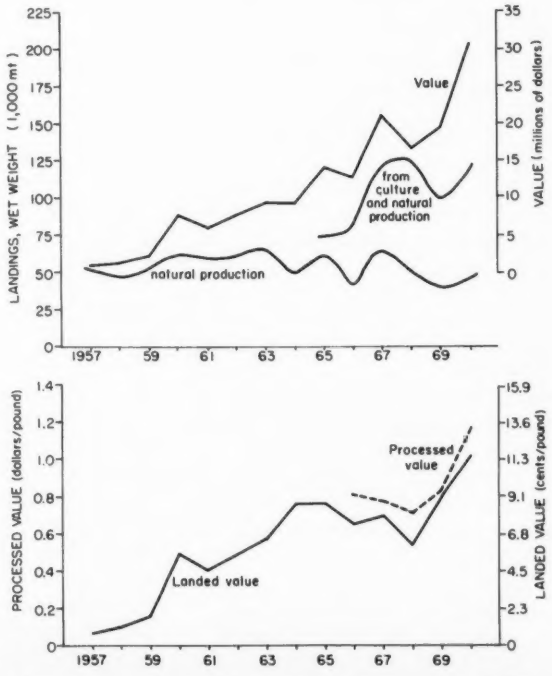

Figure 4.—Japanese production and value of "wakame," *Undaria*, 1957-70. Source: Ministry of Agriculture and Forestry, 1972a and 1972b.

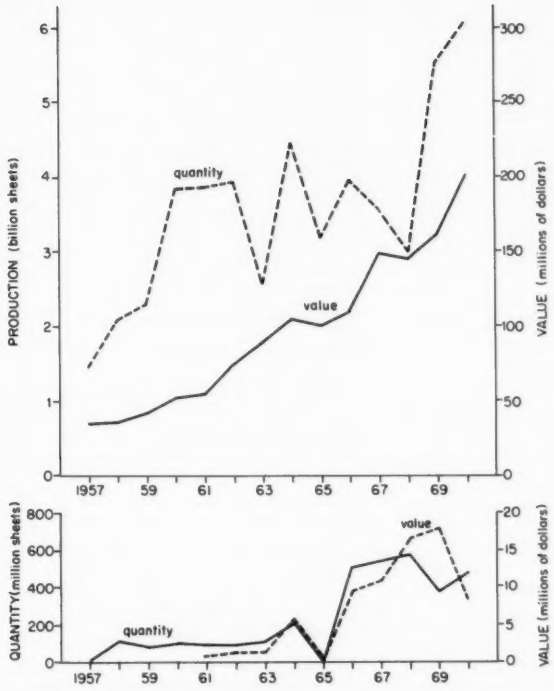

Figure 5.—Japanese production and imports of processed "nori" sheets, by quanity and value during 1957-70. Source: Ministry of Agriculture and Forestry, 1968a, 1968b, 1970, 1972a, 1972b.

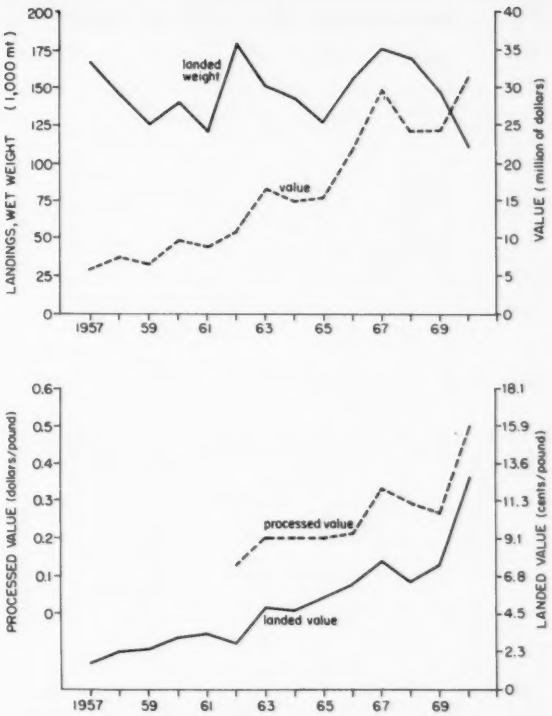

Figure 6.—Japanese production and value of "kombu," *Laminaria*, 1957-70. Source: Ministry of Agriculture and Forestry, 1972a and 1972b.

The Alaskan harvest of herring eggs-on-kelp (kazunoko-kombu), which is mostly exported to Japan, has not been included. This is classified in economic reports as fish eggs. For 1965-66 the value of this fishery was $500,000 (Anonymous, 1960-1970).

The present U.S. production of seaweeds for food is very small. Small amounts are harvested and sold fresh in Hawaii, some are processed for use by the health-food industry, and the rest are gathered by individuals for personal use. Almost all of the edible seaweeds sold in the United States are imported.

The quantity, value, and source of imported seaweed food products during 1964-71 are presented in Table 1. These imports serve the needs of Oriental communities (primarily Japanese and Korean) in the United States and consist mostly of dried nori and wakame. In Seattle, sample retail prices for dried and packaged seaweed products in 1973 were:

1) Nori—$10.31 to $56.00/lb (average $34.39). A container of seasoned nori, weighing 0.6 oz (net) and cut into small sheets, sold for $1.75.

Table 1.—U.S. imports of prepared edible seaweed products[1].

Year	Net Weight (lb)				Value ($)[2]			
	Japan	Republic of Korea	Other	Total	Japan	Republic of Korea	Other	Total
1964	283,592	49,203	179,774	512,569	408,472	78,415	16,897	503,784
1965	267,254	47,946	49,396	364,596	479,865	84,896	16,616	581,377
1966	231,676	34,827	71,915	338,418	412,628	73,321	19,444	504,393
1967	294,518	130,057	45,615	470,190	489,703	185,260	20,786	695,749
1968	269,936	61,599	359,126	690,661	509,734	173,245	62,789	745,768
1969	257,477	28,464	31,085	317,026	469,804	114,166	11,076	595,046
1970	292,142	165,876	15,506	473,524	611,204	455,168	16,088	1,082,460
1971	358,348	71,350	126,856	556,554	585,942	199,816	42,146	827,904
Average	281,868	73,665	109,909	465,442	495,919	170,411	25,742	692,060
Percent of total	61	16	23	100	72	25	3	100

[1]U.S. Bureau of the Census (1964-71).
[2]Assumed to be the FOB value, i.e., the cost or price at the manufacturing point or country of origin.

2) Wakame—$9.55 to $31.04 /lb (average $17.01).

3) Kombu—unprocessed, $2.08 to $6.36/lb (average $5.00); sliced and processed, $4.52 to $34.06/lb (average $17.10).

Increasing numbers of Japanese businessmen and tourists in the United States have increased the demands for these products. The U.S. Immigration and Naturalization Service lists the following statistics on the number of nonimmigrant Japanese who entered the United States from 1965 to 1971 (Immigration and Naturalization Service Annual Report, 1965-1971):

	1965	1971	Average annual increase 1965-71
Japanese government officials	1,399	2,541	190
Temporary visitors for business	20,193	61,473	6,880
Visitors for pleasure	18,090	181,012	27,154
Other	15,980	42,660	4,447
Total	55,662	287,686	38,671

Since Japanese Americans and non-immigrant Japanese visitors create most of the U.S. demand, areas where the incidence of people of Japanese

Table 2.—Japanese production, trade, and consumption of seaweed products[1].

Year	Domestic production	Imports	Total supply	Exports	Domestic consumption		
					Human food	Animal feed	Total
	Thousand metric tons, dry weight						
1961	85	12	97	2	61	34	95
1962	100	8	108	1	82	25	107
1963	85	10	95	1	70	24	94
1964	72	10	82	1	62	19	81
1965	81	12	93	1	70	22	92
1966	94	21	115	2	81	32	113
1967	105	18	123	2	105	16	121
1968	101	14	115	3	90	22	112
1969	89	15	104	3	77	24	101
1970	104	15	119	5	96	18	114
Avg.	91.6	13.5	105.1	2.1	79.4	23.6	103.0

[1]Data source: Ministry of Agriculture and Forestry (1968b, 1972b).

Table 3.—Average value per pound of selected seaweed and products in Japan (annual average for 1966-70)[1].

Product	Landed value (wet weight)	Processed value (dry weight)
	Dollars per pound	
Kombu, *Laminaria*	$0.08	$0.32
Wakame, *Undaria*	0.08	0.85
Nori, *Porphyra*		
Black sheet	na	0.82
Mixed sheet	na	0.71
Green sheet	na	0.27
Pieces	na	0.80
Nori seedlings	0.28	

[1]Data source: Ministry of Agriculture and Forestry (1972a and 1972b).

Table 4.—Number of seaweed culture firms (or farming units) in Japan during 1958-70 by seaweed type[1].

Year	Nori	Wakame	Kombu
1958	61,606	—	—
1959	63,726	—	—
1960	68,667	—	—
1961	68,725	—	—
1962	65,852	—	—
1963	64,183	—	—
1964	62,406	—	—
1965	62,396	6,060	—
1966	62,567	10,094	—
1967	63,705	14,184	—
1968	66,261	15,357	—
1969	65,685	15,206	—
1970	63,309	18,735	1,126

[1]Data source: Ministry of Agriculture and Forestry (1970, 1972a).

descent is relatively high, such as Hawaii, California, Washington, Oregon, New York, and Illinois would be expected to be the main centers for marketing seaweed food products. Because there are over 600,000 citizens of Japanese descent in the United States and an additional 64,000 Japanese government officials and business people, the potential market for edible seaweeds of the kinds used in Japan seems to be substantial.

Japanese Production of Edible Seaweeds

Japan is probably the largest producer and consumer of seaweed food products in the world[1]. Annual production and consumption of seaweed for 1961-70 is shown in Table 2. Landings of the four primary seaweeds harvested in Japan for 1957-70 are shown in Figure 3. Landings of "tengusa," *Gelidium*, for production of agar have been fairly constant at 10-20,000 mt (wet weight) per year, whereas those of the other three seaweeds have fluctuated rather widely.

[1]According to Silverthorne and Sorensen (1971) the People's Republic of China leads the world in seaweed harvest. Information on product forms (food versus nonfood), however, was not available.

Figure 7.—Intermediate stage in the life cycle of *Porphyra* (conchocelis). The filaments usually grow on mollusk shells.

Figure 8.—The mature stage of *Porphyra*.

Wakame (*Undaria*) landings (Fig. 4) prior to 1965 came from natural production with an annual yield of 50-60,000 mt (wet weight). Since 1965, the increased production (to 120,000 mt) resulted from the institution of culture methods. By 1970, cultured wakame made up 65 percent of the total harvest of 122,000 mt. The value of wakame landings during this period increased steadily from approximately $1 million in 1957 to $31 million in 1970 as did the bulk price—rising from 1.0 cent/lb in 1957 to 11.5 cents/lb in 1970.

Nori is harvested almost entirely from cultured crops. The harvest more than doubled in weight during 1957-60, remained about level in 1961-68, and increased by about 5 percent in 1970 (Fig. 5). Values of Japanese production of nori and of imports from South Korea in 1957-70 are also shown in Figure 5.

Japanese production and value of kombu, *Laminaria*, in 1957-69 are shown in Figure 6. Although kombu has been harvested primarily from natural beds, increasing demand has stimulated the development of culture systems. In 1970, 234 mt were harvested from cultured beds.

The average value per pound (at the primary processor level) of selected Japanese seaweed products is shown in Table 3. The number of firms engaged in seaweed culture in Japan during 1958-70 is presented in Table 4. By far the largest number were engaged in nori culture, followed by those producing wakame and finally kombu.

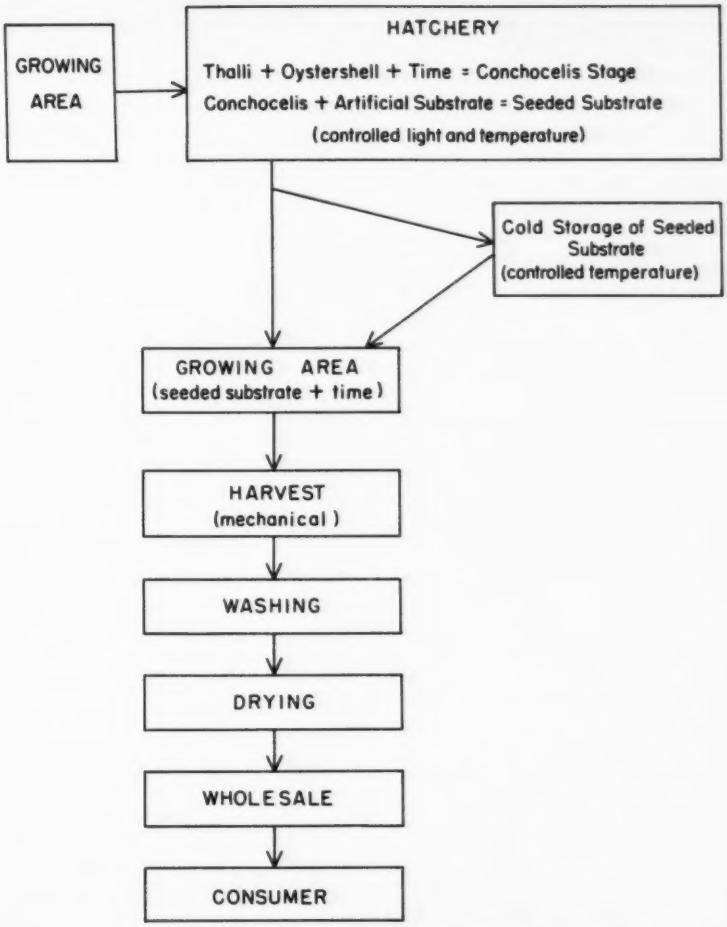

Figure 9.—Culture and processing of *Porphyra*.

POTENTIAL SEAWEED INDUSTRY IN U.S.

Growing shortages of food, fiber, and chemicals are forcing us to look more to the sea for new sources of these critical materials. The culture of seaweeds seems to offer opportunities for increasing our resource base for all three. It would also offer the opportunity for making better use of our living marine resources in territorial waters that are protected from exploitation by foreign powers.

The market for industrial products from seaweeds is well established in the United States, the raw material coming almost entirely from natural production of kelp and Irish moss. To be competitive, any system for culturing these seaweeds would have to produce a high-bulk, low-cost product. The price of raw kelp, *Macrocystis*, harvested from natural stands has been less than 1.0 cent/lb (Silverthorne and Sorensen, 1971). For Irish moss, *Chondrus crispus*, it has been 3.0 cents/lb wet weight (Anonymous, 1969). At these prices, culture of seaweed for industrial products would be difficult.

The development of culture systems for high-priced edible seaweeds, however, appears more attractive. Although the U.S. market for edible seaweeds is small compared with Japan's, the simplicity of processing edible seaweeds and the high prices that they command in U.S. markets suggests that culture and processing could be efficiently developed in the United States. If overhead could be kept low, the products could compete favorably with imports from Japan and Korea. Samples of several species of *Porphyra*, taste-tested by processors from Japan, were found to be comparable to the Japanese product. Small, family-operated businesses in the Pacific Northwest should be able to meet much of the U.S. demand for processed nori using species from the genus *Porphyra*.

Culture Systems

Nori has been cultured in the Orient since the 17th Century. Prior to that, it was gathered by fishermen from wild stands along the beach. The earliest method of culture was to place bundles of branches along the beach in early fall for collecting spores produced by mature plants. After several weeks, when growth of the thalli (leafy structures) was well underway the bundles were moved inshore

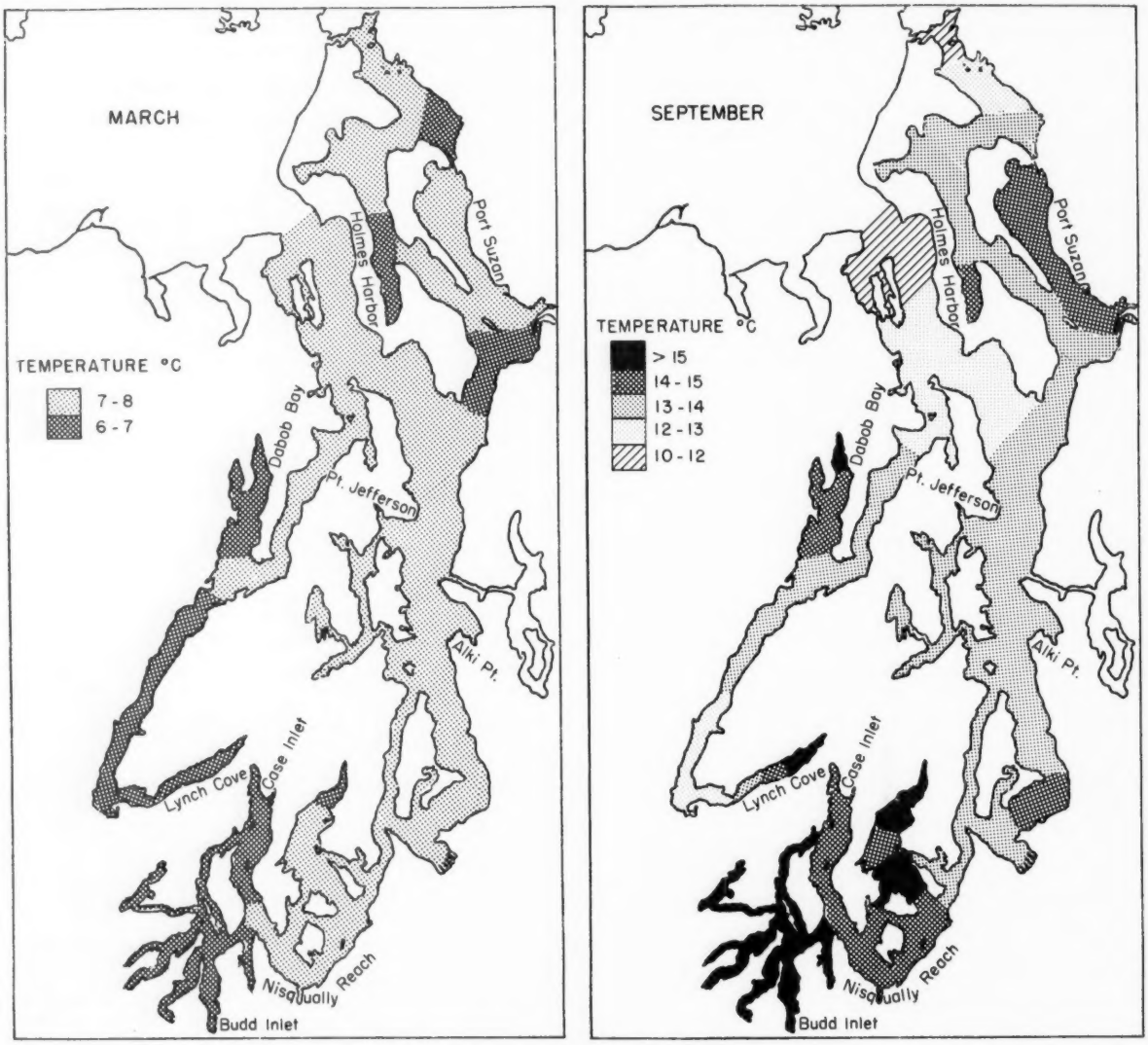

Figure 10.—Puget Sound surface temperatures in March and September.

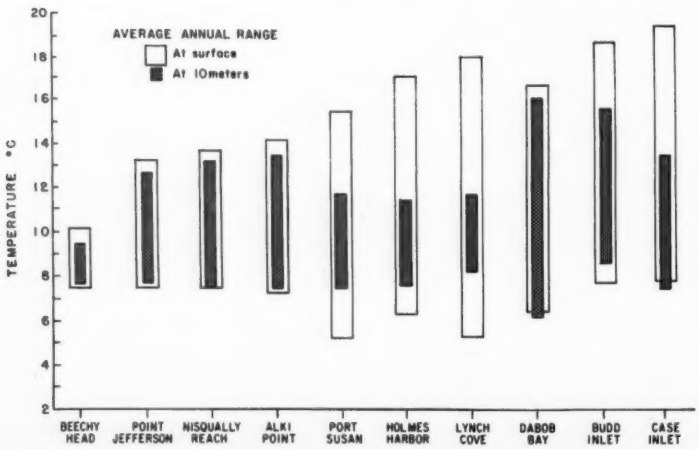

Figure 11.—Ranges of temperature at representative sites in Puget Sound.

near the mouths of rivers where there was an abundance of nutrients. Several harvests were made throughout the winter (Scagel, 1961).

Since the 1930's, large mesh nets (hibi) or split bamboo blinds (saku) have been used (Furukama, 1971). These usually measure 18.2 × 1.2 m, but can vary from 18.0 to 45.5 m in length and from 1.2 to 1.8 m in width. The hibi are set out in stacks of five at the mean tide level in early fall to collect spores. After the spores are set, the stacks are separated and the hibi moved inshore. Harvesting begins about 2 mo later. The largest plants

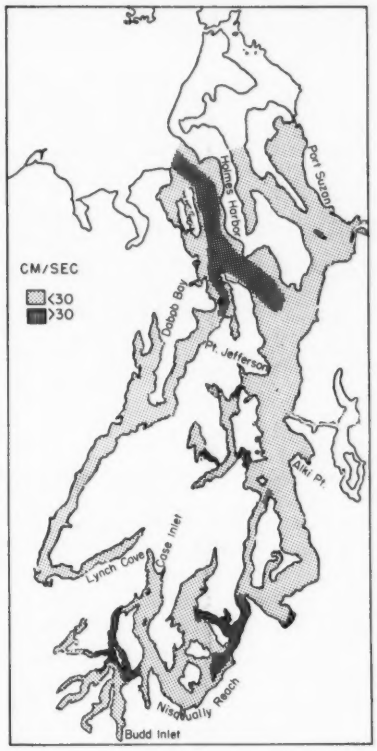

Figure 12.—Puget Sound seawater current flows.

are harvested first, allowing the small plants to continue growing. Usually three or four harvests may be made during winter and early spring (Kurogi, 1963).

The discovery by Drew (1949) of the conchocelis stage in the life cycle of *Porphyra* (nori) led to the development of new culture techniques. Under the proper temperature and light conditions, mature plants produce spores which attach to mollusk shells. These spores develop into a filamentous (conchocelis) phase (Fig. 7) that grows throughout the summer. When the temperature and light levels drop in the fall, spores are released from the conchocelis and attach to a suitable substrate to grow into leafy thalli (Fig. 8). This was the basis for the next step in *Porphyra* culture in which bags of oyster shells were hung beneath the hibi (netting used as substrate) for collecting spores. This led to the development of hatcheries, where it is now common practice to seed the hibi artificially (Fig. 9). In early spring chopped thalli are placed in tanks containing strings of oyster shells. Spores that set on the shells produce conchocelis which grow throughout the summer in the tanks. Very little care is required during this stage. In the fall, the water in the tanks is heated to forestall sporulation of the conchocelis until the hibi are ready. When the water temperature is allowed to fall below 23°C, the hibi are placed in the tanks for about 30 min. This is usually sufficient for a good set.

With the use of hatcheries, length of the growing season can be controlled by manipulating photoperiod and temperature, making it possible to spread the harvesting period over several months. By keeping the spore tanks in darkness for over 12 h each day and holding the water temperature to less than 23°C, sporulation can be accelerated to give an early start to the growing season. The growing season can be further extended by freezing the newly set spores at minus 20°C. These spores can be kept frozen for several months before setting them out. This technique also provides back-up seed stock in the event of the failure of early crops from disease or storm damage.

Potential For *Porphyra* Culture in Puget Sound

Puget Sound is well suited for the culture of *Porphyra*. These plants require water temperatures in the winter ranging from 5° to 10°C for growing the leafy thalli that can be processed into nori. For most of Puget Sound, winter temperatures range from 6° to 8°C and seldom go above 15°C in the summer (Fig. 10). Sea ice rarely forms and only in the very shallow bays does the temperature of the water consistently exceed 15°C in the summer. Figure 11 shows the maximum and minimum temperatures for some representative sites. Fed by runoff from the nearby mountains, the rivers flowing into Puget Sound carry down nutrients needed by marine plants. Currents in most areas are adequate for exchange of water and nutrients but not severe enough to cause damage or require extensive physical structures (Fig. 12). Although there is heavy cloud cover in the winter and spring, the light is sufficient for the growth of many seaweeds. One limiting factor in the growth of large leafy marine algae is the amount of stable substrate in shallow water. This is due to the sharply sloping beaches and the depths of Puget Sound. The natural substrates suitable for growing seaweed are usually restricted to the narrow intertidal or upper subtidal strips on rocky shores. Therefore, in order to utilize the waters of Puget Sound for seaweed production, an artificial substrate must be employed. Intensive, commercial culture of *Porphyra* in Puget Sound will require:

1) Development of hatcheries for controlled setting of spore.
2) Development of artificial substrates that could be used offshore.
3) Development of a mechanical harvesting system.
4) Development of a local processing capability (for making nori sheets).

Seaweeds would be very useful as a companion to other aquaculture crops such as the pen rearing of Pacific salmon in Puget Sound (Nyegaard, 1973). There are currently six salmon farms in operation, all located where water conditions would be suitable for growing seaweeds. Salmon growers possess equipment, manpower, and technology which could be readily applied to growing seaweed. Additional skills that a salmon grower would have to acquire to add seaweed to his production would be knowledge of seaweed life cycles, environmental conditions necessary to its growth, and of techniques for harvesting it.

CONCLUSION

There is already an established market for edible seaweeds in the United States that should increase. With the development of a system of offshore culture supported by spore hatcheries and a local processing capability, production of good quality nori in Puget Sound seems entirely feasible. Such a system should be able to satisfy current domestic consumption and produce a surplus that would be available for export to other countries.

ACKNOWLEDGMENT

I am grateful to George Tanonaka for background information on production and markets and to Timothy Joyner for his review and suggestions.

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MFR PAPER 1124

Consumer education by industry is needed to increase demand for fresh shellfish.

Attitudinal and Demographic Characteristics for Regular and Irregular Users of Fresh Shellfish

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INTRODUCTION

In the October 1974 number of *Marine Fisheries Review* (Vol. 36, No. 10, p. 31), the results of a survey concerning consumer attitudes and demographic characteristics for fresh finfish were reported. This same survey also collected comparable data relating to fresh shellfish. These findings are presented in this article.[1]

SURVEY METHODOLOGY

Data were collected from March to June 1972 by means of a mail questionnaire sent to approximately 4,500 randomly selected households in Cuyahoga and Summit Counties, Ohio. The principal cities within Cuyahoga and Summit Counties are Cleveland and Akron, respectively. Through subsequent phone and mail follow-ups, overall response to the survey totaled 40.1 percent (1,730 usable replies).

In addition to gathering data dealing with consumer attitudes and demographic characteristics for certain fish and shellfish products, the questionnaire elicited information regarding consumption frequencies. The findings for fresh shellfish only are discussed in this article.

Fresh shellfish was defined in the study as including all types of shellfish such as shrimp, clams, oysters, or lobsters that are purchased in unfrozen and unprepared form. Regular users of fresh shellfish were defined as respondents using fresh shellfish at home once a month or more. Irregular users, on the other hand, were defined as respondents using fresh shellfish at home less than once a month. Of the total 1,730 respondents, there were 297 regular users and 1,433 irregular users of fresh shellfish.

Attitudinal Characteristics

Attitudes of respondents towards fresh shellfish were measured by means of the semantic differential technique which combines word association with scalar values to measure concepts.[2] When completing that portion of the questionnaire utilizing the semantic differential technique, respondents were asked to judge concepts against a series of bipolar adjective scales which described the concepts on a seven point scale. For example:

FRESH SHELLFISH

Good Taste	1	2	3	4	5	6	7	Bad Taste

Progressing from left to right on the scale, the positions were described to the respondents as representing "extremely good," "quite good," "slightly good," "neither one," "slightly bad," "quite bad," and "extremely bad." Respondents were urged to mark their answers on the scales as quickly as possible and not try to analyze or select a "correct" answer.

Profiles for the regular versus irregular user groups were obtained by adding the respective weights assigned to each position on the scale and converting them into mean (average) values for each group. Comparisons were then made on a univariate basis between the respective group means ($\bar{M}$) (averages) of the regular and irregular user groups for each variable to determine if they were statistically different at a designated level of significance (0.05 in these runs). The results are summarized in Table 1.

To interpret the data in Table 1, it is necessary for the reader to consider both the group mean ($\bar{M}$) values and the corresponding F-ratios. A significant F-ratio (no asterisk) for a given variable indicates that a statistically significant difference in attitudes exists between the two groups for that particular variable. A variable's mean value ($\bar{M}$), on the other hand, indicates the direction in which the two groups scored the variable as well as the degree of the score. In Table 1, for example, the variable

Table 1.—Univariate comparisons of group attitudinal mean values for regular and irregular users of fresh shellfish.

Attitudinal variables	Group mean value: Regular users $\bar{M}$	Group mean value: Irregular users $\bar{M}$	F ratio
Taste	1.59	2.64	130.70
Taste cf. meats	2.76	3.79	104.45
Nutrition	1.95	2.52	48.40
Nutrition cf. meats	2.75	3.30	47.12
Cost	5.58	5.38	1.49*
Cost cf. meats	5.37	5.10	4.07
Aroma	3.58	4.39	56.60
Aroma cf. meats	4.16	4.82	35.87
Perishability	5.42	5.40	0.51*
Perishability cf. meats	5.43	5.26	0.89*
Preparation	2.78	3.71	87.88
Preparation cf. meats	3.28	4.01	50.85
Cooking	2.43	3.33	81.42
Cooking cf. meats	3.14	3.71	42.29
Appearance	2.62	3.75	107.12
Appearance cf. meats	3.46	4.31	90.04
Quality	3.03	3.66	44.12
Quality cf. meats	3.84	4.22	26.51
Availability	4.89	4.75	4.28
Dinner treat	2.27	3.23	59.44
Guest meal	2.31	3.43	76.07
Diet meal	1.83	2.25	23.12
Safety	2.38	2.97	41.57
Safety cf. meats	3.47	3.97	41.69

*Indicates variables nonsignificant at the 0.05 level.
Source: Survey data.

[1]The complete study, "Characteristics of Regular versus Irregular Consumers of Fin, Shell, and Canned Fish," is a result of research sponsored by NOAA Office of Sea Grant, Department of Commerce, Grant No. 2-35364. Copies are available from the author.

[2]C. E. Osgood, G. J. Suci, and P. H. Tannenbaum, "The Measurement of Meaning," University of Illinois Press, 1957, p. 24.

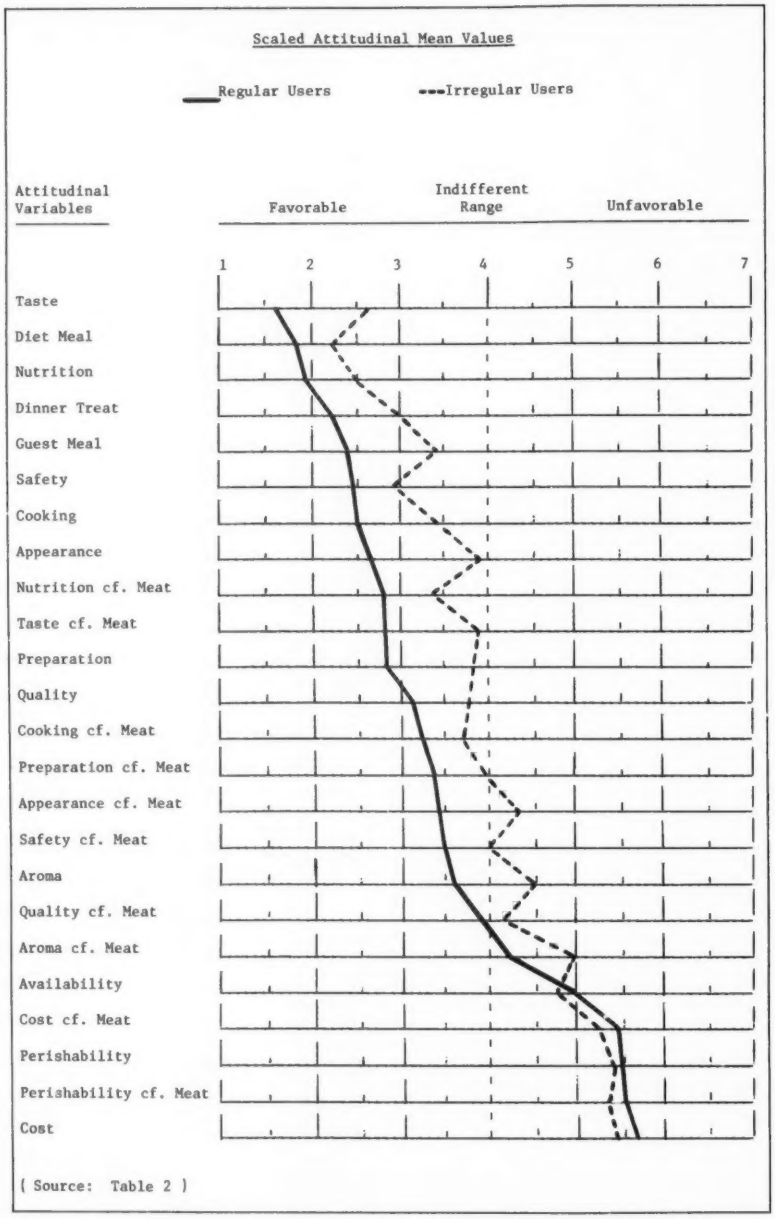

Figure 1.—Attitudinal profiles of regular and irregular user groups for fresh shellfish.

"taste" has a mean value of 1.59 for regular users of fresh shellfish and 2.64 for irregular users. The corresponding *F*-ratio of 130.70 denotes that the difference in these group mean values is statistically significant and therefore a significant difference in attitudes toward the "taste" of fresh shellfish exists between regular and irregular users of fresh shellfish. According to the mean scores of 1.59 and 2.64, however, both groups rate the taste of fresh shellfish favorably (direction of the scores on the semantic differential scale). The significant difference indicated by the *F*-ratio occurs because of the difference (degree of the scores) in mean values of the two groups.

The *F*-ratios in Table 1 disclose that in 21 of the 24 attitudinal variables, there is a significant difference between the regular and irregular user groups for fresh shellfish. Both groups rate cost, perishability, and perishability compared to meat quite unfavorably, with little difference in their scores on these variables.

The attitudinal mean values of the regular and irregular user groups for fresh shellfish in Table 1 are reproduced in scaled semantic differential form in Figure 1. In coding respondents' answers to the semantic differential section of the questionnaire, the most favorable point on each scale was assigned a value of one while the least favorable point was assigned a value of seven. The group mean scores, therefore, are interpreted as follows:

GROUP MEAN VALUE	INTERPRETATION
1.00-1.99	Extremely favorable
2.00-2.99	Quite favorable
3.00-3.99	Slightly favorable
3.50) Indifferent	
4.00)	Absolute indifference
4.50) range	
4.01-4.99	Slightly unfavorable
5.00-5.99	Quite unfavorable
6.00-7.00	Extremely unfavorable

Examination of Figure 1 shows several generalizations associated with the profiles of regular and irregular users of fresh shellfish:

1) When both regular and irregular users rate fresh shellfish favorably on an attribute, regular users rate it more favorably than irregular users. Conversely, when both groups rate fresh shellfish unfavorably on an attribute, the regular users rate it more unfavorably than the irregular users.

2) Regular users rate fresh shellfish favorably on more variables than irregular users.

3) The attitudinal mean scores of the regular user group are in the indifferent range (3.50 to 4.50) for three (12 percent) of the variables. Irregular users, however, place ten (40 percent) of the variables in the neutral range.

A closer analysis of Figure 1 shows that the attitudinal variables with mean values in the very favorable to definitely favorable (1.5 to 3.5) range for both groups are:

Taste	Dinner treat
Diet meal	Guest meal
Nutrition	Cooking
Safety	Nutrition compared to meat

Attitudinal variables scored as definitely favorable (2.5 to 3.5) by regular users, but somewhat indifferently by irregular users (i.e., the upper end of the indifferent range at 3.5 to 4.0 except for appearance compared to meat) include:

Appearance	Cooking compared to meat
Preparation	Preparation compared to meat
Quality	Appearance compared to meat
Taste compared to meat	Safety compared to meat

Attitudinal variables rated in the upper end of the indifferent range (3.5 to 4.0) by regular users, but in the lower end of the indifferent range (4.0 to 4.5) according to irregular users, are:

Aroma
Quality compared to meat

The attitudinal variable placed in the lower end of the indifferent range (4.0 to 4.5) by regular users, but considered definitely unfavorable (4.5 to 5.0) by irregular users is:

Aroma compared to meat

Lastly, attitudinal variables rated quite unfavorably according to both groups include:

Availability	Perishability
Cost	Perishability compared to meat
Cost compared to meat	

These data dealing with consumer attitudes toward fresh shellfish allow several inferences to be drawn. First, the overall profiles of the two groups show irregular users are not as enthusiastic about the favorable attributes of fresh shellfish, nor are they as critical of the unfavorable characteristics, as the regular users.

Second, both groups rate fresh shellfish very favorably to quite favorably (1.5 to 3.5) on eight variables. They agree that fresh shellfish tastes good, is a dinner treat, and is an excellent meal to serve to guests. Furthermore, they agree that fresh shellfish is easy to cook and quite nutritious on its own as well as in comparison to meat. Both groups consider fresh shellfish a safe food to eat and an excellent meal for dieting.

Third, regular users rate fresh shellfish quite favorably (2.5 to 3.5) on eight additional attributes, while irregular users are somewhat indifferent although slightly favorably inclined (3.5 to 4.0) on these variables. Appearance, ease of preparation, and quality of fresh shellfish are rated this way. The five other variables rated similarly are taste, appearance, safety, ease of preparation, and cooking characteristics of fresh shellfish as compared to meat. Fresh shellfish, accordingly, is viewed quite favorably in comparison to meat on these attributes by regular users, and on par with meat by irregular users.

Fourth, the aroma of fresh shellfish, aroma compared to meat, and quality compared to meat are regarded indifferently by regular users and indifferently to unfavorably by irregular users. While these characteristics cannot be considered strong reasons for not buying the product, they do indicate that people consider the aroma of fresh shellfish unpleasant and seem to think the quality of fresh shellfish does not measure up to meat.

Fifth, regular and irregular users alike strongly agree that fresh shellfish is not readily available, is costly in itself as well as in comparison to meat, and it perishes easily, even more so than meat. The unfavorable attitudes toward these aspects of fresh shellfish may deter regular users from purchasing more fresh shellfish than they do. It may also explain why irregular users are not regular users given the fact that they generally evaluate the other characteristics of fresh shellfish favorably.

Table 2.—Univariate comparisons of group demographic mean values for regular and irregular users of fresh shellfish.

Demographic variables	Group mean value: Regular users $\bar{M}$	Group mean value: Irregular users $\bar{M}$	F ratio
Age of housewife[a]	3.62	3.31	12.82
Age of head of household[a]	3.79	3.63	3.51*
Number of children at home[b]	2.27	2.26	0.10*
Age category of children[c]	2.54	2.33	7.95
Size of household[d]	2.44	2.43	0.01*
Education of head of household[e]	3.56	3.38	5.59
Income[f]	5.20	4.70	15.38
Protestant or not[g]	0.52	0.56	1.42*
Catholic or not[g]	0.40	0.37	0.86*
Jewish or not[g]	0.03	0.04	0.11*
White or not[g]	0.86	0.89	1.86*
Black or not[g]	0.13	0.10	1.66*

[a]Adults' age categories
(1) Under 26
(2) 26 to 35
(3) 36 to 45
(4) 46 to 55
(5) Over 65

[b]Actual number

[c]Children's age categories
(1) Pre-school (age 1-5)
(2) Elementary (age 6-12)
(3) Teen (age 13-19)

[d]Household size categories
(1) One person
(2) 2 to 3 persons
(3) 4 to 5 persons
(4) 6 to 7 persons
(5) 8 to 9 persons
(6) 10 persons or more

[e]Education categories
(1) Elementary
(2) Some high school
(3) High school
(4) Some college
(5) College

[f]Income categories
(1) Under $4,000
(2) $4,000-5,999
(3) $6,000-7,999
(4) $8,000-9,999
(5) $10,000-11,999
(6) $12,000-13,999
(7) Over $14,000

[g]Dummy variable code: 1 or 0

*Indicates variables nonsignificant at the 0.05 level.
Source: Survey data.

Demographic Characteristics

Group mean values of the demographic variables for regular and irregular users of fresh shellfish are presented in Table 2. The *F*-ratios resulting from the univariate comparisons of the group means are also given in Table 2. Codes utilized by the respondents when completing the questionnaires are shown by the superscripts (a to f) at the bottom of Table 2. It should be noted from the codes that larger mean figures are indicative of higher values for the respective demographic variables. For example, the higher the mean value for income, the larger the group's average income. This is opposite to the mean values of attitudes discussed in the previous section where lower scores are indicative of greater favorability and high scores denote disfavor. Demographic variables for race and religion present a special problem because they are qualitative rather than quantitative in nature. Accordingly, they are treated in dichotomous fashion. That is, respondents are placed in one category or another as, for example, either Protestant (1) or not Protestant (0).

The data in Table 2 show that four of the twelve demographic variables have significant *F*-ratios in the

univariate comparisons of group demographic means for regular and irregular users of fresh shellfish. These variables are:

Age of housewife
Age category of children
Education of head of household
Income

These variables indicate first, that housewives in the regular user group are older than those in the irregular user group. Second, children of families in the regular user group are older than those in the irregular user group. Third, heads of households in the regular user group have more education than those in the irregular user group. Finally, total household income in the regular user group is higher than in the irregular user group.

The demographic variables dealing with religion and race show no statistically significant differences in the univariate comparisons of group mean values for fresh shellfish. However, the group mean values for these variables suggest that the regular user group includes more Catholics, fewer Protestants, fewer Jews, fewer whites, and more blacks than the irregular user group.

CONCLUSIONS AND RECOMMENDATIONS

Similar to the findings reported for consumer attitudes toward fresh finfish in the October 1974 number of *Marine Fisheries Review*, the results of this analysis indicate that consumer attitudes toward fresh shellfish also are generally not unfavorable. Both regular and irregular users of fresh shellfish like its taste very much. Additionally, regular users feel the taste of fresh shellfish compares very favorably with most meats while irregular users feel it is slightly tastier than most meats. Both groups think fresh shellfish is easy to cook and they also feel it has an appetizing appearance. Regular users feel fresh shellfish is safer to eat than most meats while irregular users tend to be neutral on this aspect.

Regular and irregular users rate the nutritional value of fresh shellfish very highly. However, both groups feel fresh shellfish is unreasonably priced and is a less thrifty buy than most meats. Like the case for fresh finfish, both regular and irregular users of fresh shellfish express concern over the perishability of fresh shellfish. In addition to feeling it is easy to cook, both groups feel fresh shellfish is easy to prepare. Regular and irregular users, moreover, feel the quality of fresh shellfish is generally reliable. Additionally, they feel it is a special treat for dinner, a nice meal to serve guests, and safe to eat. Finally, as in the case for fresh finfish both user groups for fresh shellfish feel that it is not consistently available in food stores.

Conclusions regarding demographic variables for fresh shellfish are somewhat similar to those made for fresh finfish. That is to say, regular users of fresh shellfish generally come from older segments of the population than irregular users. The regular user group for fresh shellfish also includes more blacks than the irregular user group and regular users have older children than irregular users. Unlike the case for fresh finfish, however, regular users of fresh shellfish have higher income and education levels than irregular users.

Marketing strategies to stimulate demand for fresh shellfish should be similar in several respects to those strategies suggested for fresh finfish. That is, first of all, making supplies of fresh shellfish more consistently available should help to stimulate demand. Secondly, educating consumers along the lines of more efficient methods to store fresh shellfish should help overcome negative attitudes in this area. Strategies to change adverse feelings concerning the cost of fresh shellfish should emphasize points such as the high nutritional value of fresh shellfish, savings in time as a result of ease of cooking and ease of preparation, and the relatively low cost per serving of shellfish compared to more expensive cuts of meat. Other strategies should emphasize that fresh shellfish makes an elegant, relatively inexpensive, and generally liked meal to serve to both family and guests.

MFR Paper 1124. From Marine Fisheries Review, *Vol. 37, No. 2, February 1975. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235.*

Bypass and Collection System for Protection of Juvenile Salmon and Trout at Little Goose Dam

JIM ROSS SMITH and WINSTON E. FARR

ABSTRACT—Juvenile fish screening, bypass, and collection facilities at Little Goose Dam on the lower Snake River are described. The complex includes traveling screens for diversion of downstream migrants from turbine intakes, a bypass system for routing fish around the turbines, and a fish collection area for grading, enumeration, and examination of the migrants passed to the tailrace area. The system was operated and evaluated in 1971-72 by the National Marine Fisheries Service under contract to the U.S. Army Corps of Engineers.

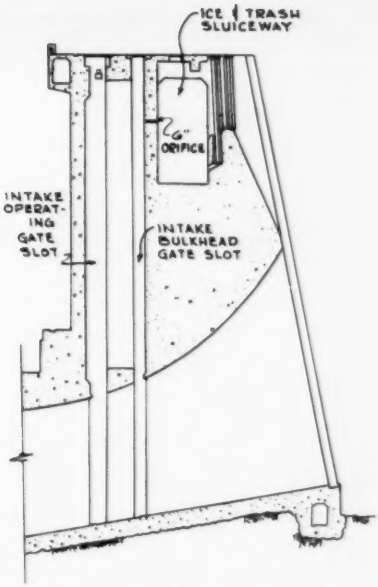

Figure 1.—Sectional view of turbine intake, gatewell, and ice and trash sluiceway.

INTRODUCTION

In recent years, solutions to problems associated with downstream passage at dams of juvenile Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, have been centered on development of safe diversion, bypass, and collection systems. For a number of years researchers working at dams on the Columbia River in the Pacific Northwest had observed juvenile fish milling in turbine intake gatewell slots (Fig. 1) and considered various methods to remove these fish safely. Fish rising up into these water-filled wells apparently did so volitionally, possibly in response to increasing pressures that prevailed on them as they were drawn into the turbine intake. Snyder[1] found in experiments at Bonneville Dam that fingerlings could be discharged safely from the gatewell slots into an adjoining ice and trash sluiceway by means of an orifice drilled in the upstream wall of a gatewell. Specific placement of an orifice in a gatewell to attain the best escapement was determined by Liscom (1971) at Ice Harbor Dam in 1965. In 1968, the U.S. Army Corps of Engineers cut two 6-inch orifices in each of three intake gatewells at McNary Dam to determine whether orifice bypasses should be installed at all dams where applicable. Bentley and Raymond (1969) found these orifice bypasses to be effective; accordingly, the Corps completed drilling of 39 additional orifices at McNary Dam and considered installation of similar bypass systems at other projects.

The orifice-bypass system installed at Ice Harbor Dam in 1970 was modified into a collection system described by Park and Farr (1972). It has been successfully used to collect or bypass juvenile seaward-migrating salmon and trout.

Fingerling bypass systems were incorporated in the design and construction of recently completed dams such as John Day (1968), Lower Monumental (1969), and Little Goose (1971), but they differ from those installed at earlier dams in that an enclosed fish-transport pipe is used to pass fish around the turbines instead of an ice and trash sluiceway.

During the time that studies were being conducted on orifice bypass systems, concurrent research was underway to determine whether greater numbers of fish could be diverted into the gatewell slots and thus be prevented from entering the turbines. Laboratory studies by Marquette and Long (1971) indicated that a screen placed to intercept migrants traveling near the ceiling of a turbine intake was successful in diverting 87 percent of the fish entering the intake into the gatewell slot. A prototype traveling screen was subsequently installed in a turbine intake at Ice Harbor Dam to test this concept under actual field conditions.

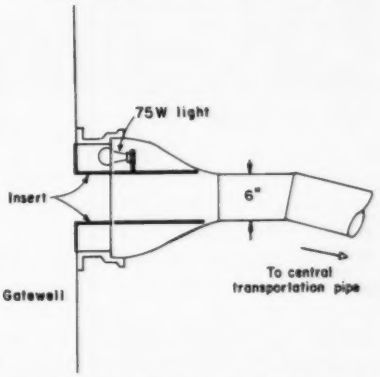

Figure 2.—Gatewell orifice showing insert modification of bell shape and placement of light.

In these preliminary tests made in 1968, the traveling screen diverted

[1]Snyder, G. R. 1964. Passage of downstream migrating salmonids through an orifice in a turbine intake gatewell at Bonneville Dam. Review of Progress 1964, Vol. 4, Paper 53. Fish Passage Research Program, Bureau of Commercial Fisheries, USFWS, Seattle, Wash. 4 p. (Processed.)

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Figure 3.—Fish bypass transport pipe (dark arrow) and raceways for holding juvenile salmon and steelhead trout at Little Goose Dam. Transport pipe discharges through upwell at left end of fish holding area (light arrow).

about 75 percent of the juvenile chinook salmon, *O. tshawytscha*, and 25 percent of the juvenile steelhead trout from the turbine intake into a gatewell slot. Further mechanical improvements were made, and three experimental traveling screens were placed in operation at Little Goose Dam in 1971 to determine the feasibility of utilizing a complete diversion and bypass system for either collection and transport or diversion and bypass to the tailrace of a major portion of the fish entering operating turbine units.

This report describes the system installed and tested at Little Goose Dam in 1971-72. The study was part of a continuing cooperative effort between the National Marine Fisheries Service (NMFS) and the U.S. Army Corps of Engineers to improve fish passage on the Columbia and Snake Rivers.

GATEWELL ORIFICES AND TRANSPORTATION PIPE

Passage of fish from a gatewell slot at Little Goose Dam was provided through a submerged orifice. The

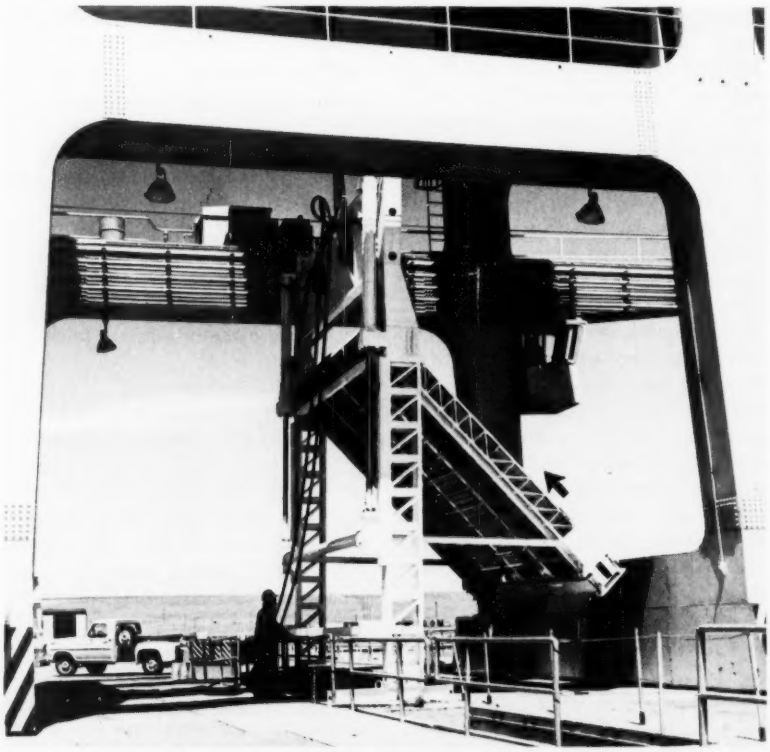

Figure 4.—Traveling screen assembly. Screen is shown extended and in the operating position. Arrow designates direction of travel.

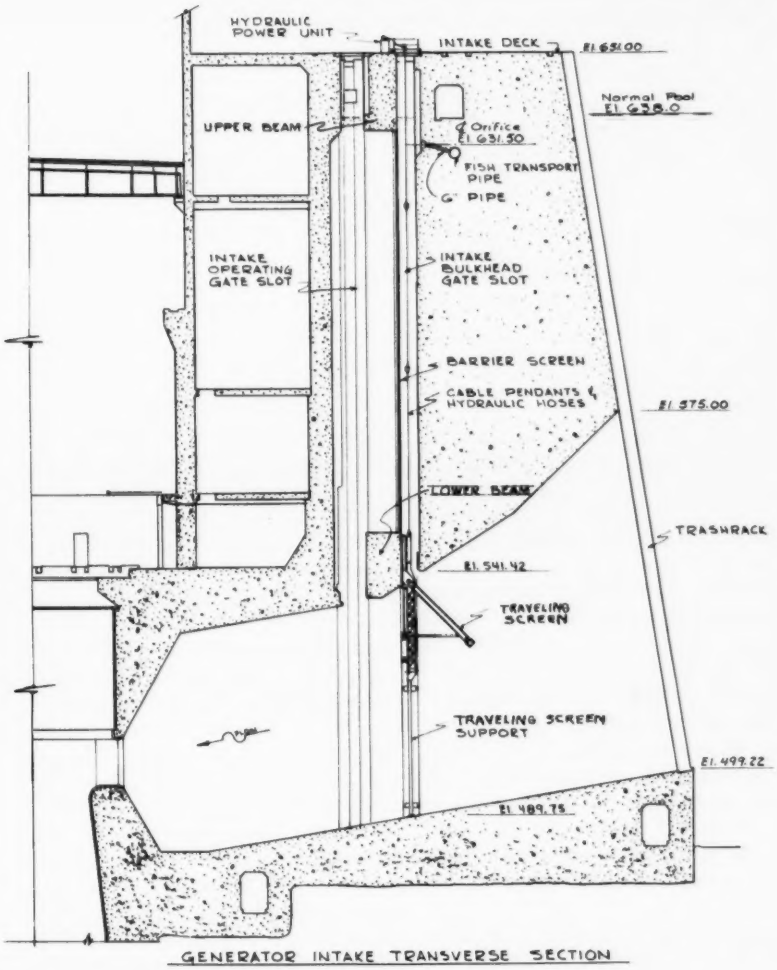

Figure 5.—Sectional view of turbine intake unit at Little Goose Dam showing traveling screen, barrier screen, support structure, gatewell orifice, and fish transportation pipe.

original orifice was bell-shaped, measuring 14 inches in diameter at the inlet and tapering to 6 inches at its connection with the short section of pipe leading to the main transportation pipe. The latter passageway was 1.0 ft in diameter at the southern end of the powerhouse, enlarging to 3.0 ft at the northern (downstream) end. Each orifice was located in the northeast corner of the gatewell, 20.5 ft below the intake deck and submerged from 1 to 7 ft, depending upon forebay elevation. Because the quantity of water discharged from the main transportation pipe was controlled, intake velocity at the orifices changed very little. Initial observations indicated that the unlighted, bell-mouthed opening was relatively ineffective in attracting available fish from the gatewell. On the other hand, previous tests at McNary and Ice Harbor Dams had indicated that a naturally-lighted, straight 6-inch diameter opening was far more effective. Therefore, the orifices at Little Goose Dam were modified to provide 6-inch diameter lighted orifices (Fig. 2).

Water and fish passing through the individual orifices entered the central transportation pipe and were discharged into the tailrace in the area between skeleton turbine unit number 6 and the first spillway bay. Subsequently, the bypass was extended from the original point of discharge by adding approximately 900 ft of 24-inch pipe across the face of the tailrace deck and downstream to fish-holding raceways located on the south shore below the dam (Fig. 3). Fourteen tapered baffles were placed in the interior of this extension to maintain water velocity at 9 fps near the downstream extremity. Each baffle restricted flows to a 15-inch diameter orifice; calculated velocity through these orifices was 23 fps. The system was designed to deliver 28 cfs of water at all times regardless of forebay level. This flow passed into a 5-ft diameter upwell pipe through a water elimination system and discharged the fish into a fish grader located at the fish-holding area.

FISH SCREENING FACILITIES

Typical Kaplan turbine units at dams on the Columbia and Snake Rivers have three separate intakes; hence, three individual screens are required to divert fish from each turbine unit. The first experimental traveling screen (Fig. 4) installed at Ice Harbor Dam was modified to fit slot dimensions at Little Goose Dam. Two additional traveling screens were constructed and installed at the latter site in the spring of 1971 to divert fish entering one of the three operating turbines.

Components of the traveling screen assembly included a rotating belt screen (20.75 × 22.0 × 1.5 ft), an outer framework for housing the belt screen and drive mechanism, and a support structure (23 × 30 × 3.66 ft) upon which the screen was positioned when operating in the turbine intake. The traveling screen unit was bolted to, and rested on, the support structure. Screen belting consisted of four woven panels of E42 × 36 × 16 wire. Power for rotating the screen at 0.5 fps was supplied by two hydraulic motors connected to gear boxes with a 7:1 reduction. One gear box and motor were attached to each end of the top shaft of the screen. Direction of screen travel was upward on the upstream face and downward on the returning side (Fig. 4).

Installation of the traveling screen assembly was as follows: The turbine was shut down and the bottom support structure was partially lowered into a gatewell and dogged off. The collapsed traveling screen unit was then lifted with the gantry crane, lowered onto the support structure and the

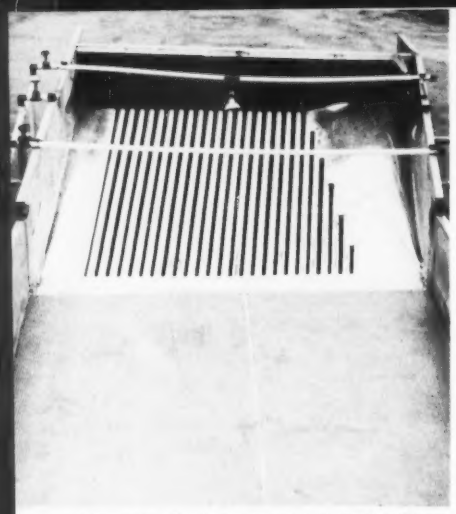

Figure 6.—Overhead view of fish grader. Shown are the perforated plate, grader bars, and sprinkler system.

two sections were bolted together. After removal of the dogs, the total assembly was then lowered into the intake by use of cable pendants. When the support structure reached the bottom of the turbine intake, the cable pendants were dogged off. The traveling screen was then tilted into operating position at approximately 45° by activation of the hydraulic pistons. After the traveling screen had been placed in position, the valve controlling the movement of the traveling screen conveyor belts was activated, and the system was ready to divert fish (Fig. 5).

Separate 25-hp hydraulic power units were used for each traveling screen. These units were located on the deck adjacent to the gatewell opening. Installation and removal of the hoses were expedited with quick-disconnect couplings. Hoses between the top of the traveling screen frame and the intake deck were of the same length as the cable pendants so they could be installed and removed simultaneously. A more detailed description of the design and operational features of the turbine intake traveling screen is given by Farr (In press).

Fish diverted into the bulkhead gate slot were confined to that area by a vertical barrier screen which prevented movement into other areas of the gatewell (Fig. 5). Prior to the addition of this screen, fish entering the gatewell could pass downstream around the lower beam and back into the turbine intake. Three barrier screens were required for each turbine intake. These were installed in guides fastened to the gatewell walls. Each screen was 21 ft wide by 84 ft deep. Subsequently, portions of these screens (upper and lower ends) were covered with paneling to control flow turbulence at surface levels in the gatewells. Before installation of the panels, a pronounced upwelling was evident in the gatewells and was believed to have had an adverse effect on egress of fish to the bypass pipe. This surface turbulence was largely eliminated when the panels were installed.

UPWELL AND FISH GRADER

Fish emerging from the upwell at the terminus of the transportation pipe spilled over a perforated-plate screen and then on to the fish grader (Fig. 6). The flow of water to the fish grader was regulated by porosity-control gates beneath the perforated-plate screen (Fig. 7). Water passing through the screen could be diverted to the holding raceways or returned directly to the river. The fish grader consisted of aluminum tubes 1.25-inches in diameter and 10 ft in length which were progressively spaced from narrow to wide openings to grade fish into three size categories. Spacing could be varied to accommodate the various sizes of fish. Graded fish fell into one of three water-filled hoppers located below the bars. Fish leaving these hoppers passed through a pipe containing an electronic counter and into one of the five holding raceways.

The grading system functioned satisfactorily, but small debris periodically passed into the raceways and occasionally plugged the fish transfer pump used to lift fish from the raceways to the marking facility. In the fall of 1972 a traveling debris carrier belt (Fig. 7) was placed between the grading bars and the hoppers. This belt consisted of 5/16-inch cross rods spaced 2 inches on centers with the ends of the rods passing through holes punched in the side bars of C2080 chains. These rods were covered with 0.5-inch schedule 80 PVC pipe, leaving a gap of 1.5 inches between the individual cross rods. A preliminary test showed that fish were separated from debris and that about 90 percent of the debris was removed from the system.

When desirable, fish emerging from the upwell could be bypassed directly to the river by merely covering the grader bars with a metal sheet. Fish

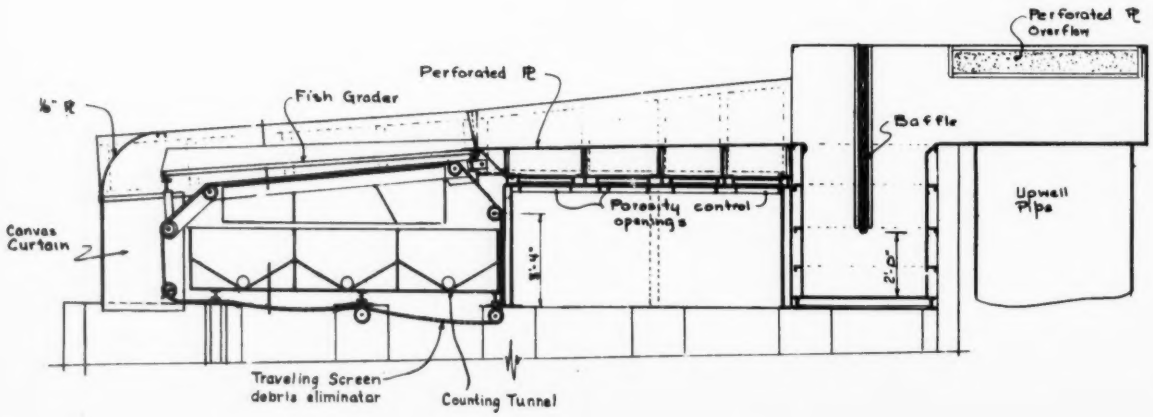

Figure 7.—Sectional view of separator showing upwell pipe, perforated plate, fish grader, and debris eliminator.

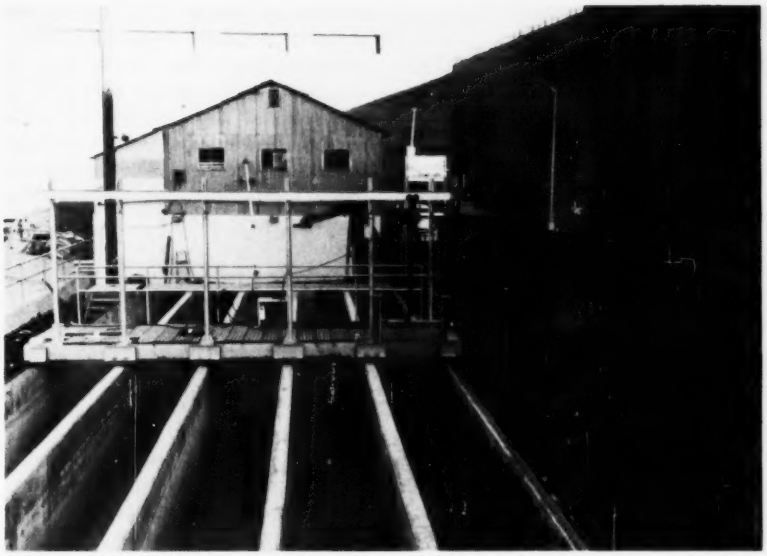

Figure 8.—Fish crowder with single screen in position in raceway on extreme right. Fish-marking facility is in background.

passed in this manner entered a pipe at the end of the grader and were discharged into the frontroll of the turbine discharge.

FISH HOLDING AREA

The fish-holding area consisted of five adjacent raceways 80 ft long × 4 ft wide × 7 ft deep. Each raceway was provided with an inlet and outlet screen which prevented escapement of fish. Water flow and depth in each raceway were controlled by adjustment of stoplogs at the head and end of the raceways; excess water spilled back into the Snake River. Cooling water could be provided when needed by three 30-ton chillers plumbed into the raceways.

When fish were removed from the holding area for transfer to the marking building or to fish-transport trucks, each raceway was handled independently. Water depth in a designated raceway was lowered to 2 ft by lifting stoplogs at the downstream end. The outlet screen was then pulled and fish were crowded toward the intake of the fish pump.

The crowder (Fig. 8) ran on tracks mounted on the two outside walls of the fish-holding area and was powered by a variable-speed, reversible electric motor with reduction gear. A single crowder screen was connected to a traversing hoist to permit ready transfer to any raceway. To remove fish from a raceway, the crowder tramway was moved to the inlet screen and the crowder screen lowered into position. The outlet screen of the raceway was then removed, a slide-gate valve to the pump-intake pipe was opened, and the fish pump was activated. The crowder was then moved down toward the exit to concentrate all fish near the pump intake. From this point the fish were either pumped into the marking facility or directly to a transport truck.

The transfer pump was a 5-inch, helical port-impeller type, driven by a 7.5 hp variable-speed motor. Diameter of the pump intake was 6 inches. During initial tests in 1971, before the installation of the debris eliminator, periodic inspection revealed that sticks (8-inch or longer) occasionally lodged at the junction of the intake pipe and the helical impeller; this condition caused some descaling and injury of fish. A clear plastic section of pipe was installed at this junction to permit ready detection of debris. Where noted, the debris could be immediately removed by unbolting the intake pipe. Total dynamic head (TDH) of the pump comprised 6 ft of suction lift and 12 ft of discharge head.

SUMMATION

In general, the fish diversion, bypass, and collection system at Little Goose Dam operated satisfactorily in 1971-72. More recent inspections in 1973 indicated that incidence of descaling and general physical condition of the fish were directly associated with turbine load and related approach velocities on the intake traveling screens. Further improvements and modifications to the system are planned and will be tested in forthcoming years.

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NOAA Awards Honor Employee Achievements

Five persons were presented 1974 NOAA Awards by National Oceanic and Atmospheric Administration Administrator Robert M. White at a luncheon at Bolling Air Force Base, Washington, D.C., 11 October 1974. The Commerce Department agency also recognized two employees for outstanding achievement in its Equal Employment Opportunity program.

The $1,000 NOAA awards from the nation's civilian air-sea agency honored distinguished accomplishment for direction of U.S. participation in the world's largest weather experiment; automation of the National Weather Service's field operations; world leadership in magnetospheric physics; helping American surveyors toward modern practices; and major contributions to the development of a minority crab processing business.

Recipients were: Douglas H. Sargeant of NOAA's headquarters in Rockville, Md., Director of the U.S. Project Office of GATE—the Atlantic Tropical Experiment of the Global Atmospheric Research Project—for Program Administration and Management; Robert E. Johnson, Chief, Systems Integration Division, Systems Development Office, National Weather Service, Silver Spring, Md., for Engineering and Applications Development; Donald J. Williams, Director of the Boulder, Colo.-based NOAA Environmental Research Laboratories' Space Environment Laboratory, for Scientific Research and Achievement; Joseph Dracup, supervisory geodesist of the NOAA National Geodetic Survey in Rockville, Md., for Public Service; and Burton L. Tinker, food technologist at the Northeast Utilization Research Center of the NOAA National Marine Fisheries Service, Gloucester, Mass., for Public Service.

Sargeant has directed U.S. preparations for and participation in GATE, the field phase of which was recently completed off Senegal, Africa. The experiment involved approximately 4,000 persons from 70 nations, and a wide array of satellites, aircraft, ships and other platforms. Sargeant, more than any other individual, has contributed to the highly successful execution of the observational phase of the GATE program. His resourceful management helped overcome threatened loss of vital satellite information and other equipment difficulties, during the project. His skill in complex international negotiations helped bring agreements acceptable to all nations concerned. "Largely as a result of his keen judgment and diligence," his award states, "this program will be recorded as a monument of scientific accomplishment."

Johnson, affiliated with the National Weather Service since 1966, has pioneered in the application of modern engineering technology to field operations. In 1971, he led in analyzing these operations in terms of their suitability for automation. From his efforts came the NWS' recently-unveiled Automation of Field Operations and Services (AFOS) Program, designed to speed and improve weather forecasts and warnings. He directed the development of an experimental model AFOS station, a system hailed as one of the most advanced applications of minicomputer technology in the Nation.

Williams, Director of NOAA's Space Environment Laboratory since 1970, has organized the best magnetospheric and one of the best interplanetary medium research groups in the United States. An expert in the dynamics of magnetospheric particle populations, he was instrumental in developing detectors for the measurement of ions and electrons at very low energies, and has used the instrumentation of 12 satellites to map the magnetosphere's charged-particle population in space and time. His work has eliminated areas of major ignorance about magnetic storms.

Dracup for many years has devoted much of his own time helping surveyors through the transition to modern methods that use NOAA's products and services. He has organized and participated in many workshops, usually on weekends, instructing surveyors in modern methods. Federal, state, and local surveyors have been assisted by these efforts.

Tinker, in 1970, began counseling a New Bedford, Mass., minority group interested in processing red crab, an underutilized shellfish. His technical assistance included aid in the preparation of proposals and plant design requirements. The group, which eventually became the New Bedford Atlantic Associates, received an Economic Development Administration grant in 1972 to undertake a pilot project. In 1973, Atlantic Associates materially expanded operations and on 30 August 1974 broke ground for a new plant in New Bedford. Tinker's assistance, much of it in off-duty hours, contributed significantly to the success of the venture.

Receiving $500 NOAA Equal Employment Opportunity Awards will be NOAA Assistant Administrator for Administration Theodore P. Gleiter and Jacqueline A. Coit of NOAA's National Marine Fisheries Service.

Gleiter has been cited for continuing aggressive and imaginative leadership in all aspects of EEO. He has pointed out areas in employment where minorities and women tend to be locked into dead-end jobs, and has sponsored and encouraged a number of upward mobility programs to enable lower-level employees to enter new careers. Through various NOAA programs, he has assured that his own division has increased its number of minorities and women at higher grade levels. He has initiated programs in career counseling and race relation seminars to help managers and supervisors, as well as employees, come to a better appreciation and understanding of the problems of minorities and women.

Coit, an Administrative Assistant at NOAA's Southwest Fisheries Center in La Jolla, Calif., was recognized for "exceptional initiative and effort in encouraging the employment of handicapped individuals." She was instrumental in the recruitment of several severely handicapped individuals at the center. She has also contributed to EEO progress in the employment of minority and female candidates at the center, contacting and working with the Neighborhood Youth Corps, Work Incentive Program, Urban League, summer aid program, Upward Bound groups and

others. She has presented lectures on National Marine Fisheries Service job opportunities to minority and school groups, stressing the EEO plan, and maintains contacts with minority and women's organizations to establish continuing relationships and increased recruitment opportunities.

Regulations on Taking Marine Mammals Printed

Commercial fishermen who take marine mammals while fishing were required to be included under a general permit after 20 October 1974, according to the Commerce Department's National Oceanic and Atmospheric Administration.

The Marine Mammal Protection Act of 1972 was passed to protect, maintain, and if necessary rebuild the populations of marine mammals. The Act, among other things, restricts the taking and importing of marine mammals and marine mammal products.

Because there are times when fishermen might unavoidably take marine mammals during their normal fishing operations, it was necessary to make provisions in the Act which would allow fishermen to take marine mammals incidental to their commercial fishing operations.

A system was established by NMFS/NOAA whereby organizations representing fishermen could apply for a general permit to cover fishing operations using five general categories of fishing gear. Once these general permits had been issued, individual commercial fishermen could be included under the general permit by applying for a certificate of inclusion under one of the five categories.

Conditions of the general permits, and the certificates of inclusion under the permits, require, among other things, that commercial fishermen take special measures, and in some cases use special fishing gear, to avoid injuring or killing marine mammals in their fishing operations. If a marine mammal is killed or injured it must be reported to the National Marine Fisheries Service or a State enforcement agency.

NOAA's National Marine Fisheries Service published regulations controlling the incidental taking of marine mammals in the Federal Register on 5 September 1974, to become effective on 30 September 1974. These regulations, as amended, govern the issuance of general permits and certificates of inclusion.

The initial general permits and related certificates of inclusion will be good until 31 December 1975. General permits and certificates issued thereafter will expire 31 December of the year they are issued.

The five general categories of fishing gear are towed or dragged gear; encircling gear, yellowfin tuna purse seining; encircling gear, seining other than yellowfin tuna; stationary gear; and other gear such as trolling, gill nets, and hook and line gear.

Applications for the certificates of inclusion will be accepted at the National Marine Fisheries Service's Regional Offices in Seattle, Washington; Terminal Island, California; Gloucester, Massachusetts; St. Petersburg, Florida; and Juneau, Alaska.

Applications for certificates of inclusion will include the name of the person(s) which is to appear on the certificate, the category of general permit under which the applicant wishes to be included, the species of fish sought and general area of operation, identity and date of expiration of State or local commercial fishing licenses, if any, under which fishing operations are conducted, and the name and signature of person making application.

Cost of the certificates is $10 for everyone applying under all categories except yellowfin tuna purse seining encircling gear, which is $200.

NOAA Dedicates New Great Lakes Facility

Officials from the National Oceanic and Atmospheric Administration dedicated the new Great Lakes Environmental Research Laboratory in Ann Arbor, Mich., 18 October 1974. Representative Marvin L. Esch, U.S. Congressman from Ann Arbor, was the principal speaker at the afternoon ceremony. John K. Tabor, Under Secretary of Commerce; Wilmot N. Hess, Director of NOAA's Environmental Research Laboratories; Charles G. Overberger, Vice-President for Research of the University of Michigan; and Jack E. MaKeever, Executive Director of the Ann Arbor Chamber of Commerce, also participated. Eugene J. Aubert, Director of the new laboratory, discussed some of its objectives and projects.

Formally established on April 25, the Great Lakes laboratory is the newest of the Commerce Department agency's Environmental Research Laboratories, headquartered in Boulder, Colo. It brings together researchers from the limnology and computer divisions of the National Ocean Survey's Lake Survey Center in Detroit and NOAA scientists working on the International Field Year for the Great Lakes (IFYGL). The new laboratory's 30 scientists are investigating the total lake ecology—waters, sediments, life forms, climate, and surrounding terrain.

The main task of the Great Lakes laboratory for the first few years will be continued analysis of the data collected during IFYGL in 1972-73. The project is a joint U.S.-Canada study of Lake Ontario. Aubert estimates that IFYGL will occupy two-thirds to three-fourths of the laboratory's efforts until 1977.

Research at the laboratory will take two directions. Basic research will contribute to the background of general knowledge about the lakes. Other projects are aimed at providing improved environmental information to solve specific problems or meeting specific needs, such as improving navigation or preventing erosion or pollution.

The emphasis will be on interdisciplinary research, says Aubert. The laboratory will also provide environmental information and advisory services to planners and policy makers in government and private organizations.

Among the main long-range goals of the laboratory will be comprehensive models of lake circulation, lake ecology, lake levels, and flows. Studies will focus on waves and currents, design and siting of power plants, pollution of public beaches, lake climatology, winter ice, lake hydrology, the population dynamics of key organisms, and water quality in the various bays, rivers, and harbors.

The facilities at Ann Arbor will include laboratories for studies of water chemistry, sediment, biology, and ice. A lakeside facility at Monroe, Mich., will provide a starting point for field research. For research on the waters of the lakes, the limnologists will use the 65-foot research vessel, *Shenehon*, operated by NOAA's National Ocean Survey.

NMFS IMPORT INSPECTION SERVICE NOW IN USE

Boston Bonnie, Inc., Boston, Mass., one of the country's largest importers of fisheries products, is the first to use the Import Inspection Service offered by the Department of Commerce's National Oceanic and Atmospheric Administration.

The service includes technical assistance in developing purchasing, processing, and end-product specifications; determining compliance with the importers' requirements; and pretesting and analyzing the imported seafoods for wholesomeness, quality, and condition. Assistance is also provided to the importer with product labeling, quality assurance, sanitation, and other problems.

The import inspection service is one of several inspection services administered by NOAA's National Marine Fisheries Service which will help to assure manufacturers that the fisheries products they offer to the consumer are safe, clean, and wholesome. The inspection is provided on a fee-for-service basis to anyone involved in distributing and processing fisheries products.

Boston Bonnie, Inc., employs over 100 people and imports millions of pounds of fisheries products a year for processing and worldwide distribution.

David M. Trilling, Vice President of Boston Bonnie, Inc., points out that inspection protects the foreign shipper as well as the U.S. receiver by providing certificates of the condition of the products at the time of the inspections. He feels that this is a step forward in assuring the processor that the imported fisheries products he uses are of high quality, thus providing a better product to the consumer.

Extensive Gulf of Alaska Ecological Study Is Assessing Probable Oil Lease Impact

What could possibly be one of the richest oil discoveries since Alaska's Prudhoe Bay—the oil-bearing formations beneath the continental shelf in the Gulf of Alaska—could also pose a formidable set of ecological questions.

The National Oceanic and Atmospheric Administration, working with other Federal and State agencies in a major investigation for the Bureau of Land Management, U.S. Department of the Interior, is attempting to assess this risk so that it can be weighed against the national imperatives for developing adequate domestic energy sources.

The $2.5 million project focuses on an area in the northeast Gulf of Alaska between Prince William Sound and Yakutat Bay, a region thought to contain potential petroleum reserves —and to present some difficult environmental problems.

The study is managed by the Marine Ecosystems Analysis (MESA) program office of the Commerce Department agency's Environmental Research Laboratories in Boulder, Colo., and coordinated for the Bureau of Land Management by its Outer Continental Shelf office in Anchorage, Alaska.

"This kind of investigation," says Wilmot N. Hess, director of the NOAA laboratories, "is an absolutely essential prelude to outer continental shelf petroleum development."

"In the view of many environmental scientists in Federal agencies and private institutions alike, baseline environmental studies are needed to quantify our present rather subjective understanding of the risks of outer continental shelf development. Without quantification of these risks—that is, without knowing which action produces which environmental consequences—we cannot compare the probable risks with the probable benefits of development."

Although the project is managed by NOAA, it will draw on the special talents and experience of scientists in NOAA and in such institutions as the University of Alaska, Alaska Department of Fish and Game, and the Interior Department's Geological Survey and Fish and Wildlife Service. Herbert Bruce, of NOAA's National Marine Fisheries Service Auke Bay, Alaska, laboratory, directs the project in the field.

The Council on Environmental Quality, in its April 1974 report, indicated that oil development in the northeastern Gulf of Alaska presented potentially greater environmental risks than in any other continental shelf area studied. Among the special problems of the area cited by the Council were a superficial understanding of the region's rich, complex, and economically important marine ecosystem; the effect on possible oil spills, of tides, currents, and winds; the hazard presented to offshore facilities by the furious maritime storms which parade across the Gulf; and the relatively high level of seismicity (earthquake activity) and the earthquake-generated sea waves called tsunamis.

These crucial unknowns played a key role in shaping the present study, which in its first year will emphasize measurement and analysis of the key environmental factors which must be quantified before oil exploration, drilling, and production can begin.

In the first year's effort, the investigators hope to:

1) Characterize the circulation of the ocean (and estuarine) waters of the region, both over the continental shelf and offshore, identify the dominant dynamic mechanisms involved in flow patterns and mixing processes, describe characteristic waves and weather, and develop numerical models as aids in interpreting results and exploring simple dynamic processes. This will be a cooperative effort of the Pacific Marine Environmental Laboratory (one of the Environmental Research Laboratories) in Seattle, Wash., NOAA's National Ocean Survey, and the Institute of Marine Sciences at the University of Alaska.

2) Develop a comprehensive knowledge of the area's seabed geology and the sediment flow from contributory rivers, assess the earthquake hazard there, and delineate natural oil seeps —the sources of nature's small, chronic "oil spills." This part of the study

will be undertaken by the Interior Department's Geological Survey.

3) Provide baseline characteristics of the seabed and water-column chemistry, with emphasis on establishing natural levels of hydrocarbons and distributions of trace metals (for example, nickel, cadmium, zinc, copper, and mercury) in the marine environment and its life before petroleum development begins there. The chemical program will be conducted by NOAA's Northwest Fisheries Center, Seattle, Wash., and the University of Alaska's Institute of Marine Science, in consultation with the Commerce Department's National Bureau of Standards.

4) Complete a thorough census and description of the micro- and larger organisms which constitute the region's marine and estuarine population, particularly the fragile ecosystems of the intertidal regions, and assess the abundance of marine birds and mammals in the study area and how these populations vary seasonally. The biological program will be carried out by NOAA's Northwest Fisheries Center, the Institute of Marine Science of the University of Alaska, the Alaska Department of Fish and Game, and the Interior Department's Fish and Wildlife Service.

A follow-on program of studies designed to refine further scientific understanding of the study area's marine ecosystem and the possible impacts of oil exploration, production, and transportation, will be proposed early this year. A final report of the project's first-year results will be issued by mid-August.

NOAA Issues Coastal Management Criteria

A key set of criteria to guide the management of the nation's coastal areas has been issued by the National Oceanic and Atmospheric Administration (NOAA), a Department of Commerce component. They outline basic elements that a State coastal management program should contain to qualify for approval by the Secretary of Commerce and were published in draft form in the Federal Register on 21 August 1974.

The criteria were issued in response to the Coastal Zone Management Act of 1972. The Act provides Federal funds to State governments wishing to develop coastal management programs. Participation in the program is voluntary, but all 34 eligible States and territories were expected to take part in 1974.

Under the Act, the 30 coastal States (including those along the Great Lakes) and four territories may submit for Federal approval management programs for protecting, developing, and restoring coastal lands and waters. When the Secretary approves the program, the State becomes eligible for additional funds to assist in its implementation. In addition, Federal activities carried on in the coastal zone, or which may affect the coastal zone—including grants, loans, licenses, and permits—must be conducted in a manner consistent with the program.

Among the new criteria is the provision that the management program describe how the State will exercise control over the use of coastal resources of Statewide interest in cooperation with local governments and regional bodies.

Another criterion provides that States designate areas of particular concern within the coastal boundary. Areas, for example, which are of historical and scenic importance as well as of significant ecological value. Additional consideration should be given to coastal areas vulnerable to natural disasters or of high recreational potential and urban concentration.

Recent proposals to accelerate oil and gas production in the offshore waters of the United States have intensified interest in wise coastal zone management. Oil refineries, beaches, harbors, second homes and condominiums, power plants, wildlife refuges, airports, highways and commercial development all compete with one another for a relatively limited, but extremely critical, strip of shoreline.

Robert W. Knecht, director of NOAA's Office of Coastal Zone Management, says the new criteria "represent a major step forward in building the kind of 'shared partnership' between the Federal, State and local governments that is visualized in the Coastal Zone Management Act." He added, "Coastal States are encouraged to submit coastal zone management programs meeting the criteria established by the Secretary of Commerce. In exchange, the Federal Government is committing itself to conform Federal actions to the approved State program." Knecht emphasized that the basic coastal resource management decisions would continue to be made by State and local governments.

Marine Pollutant Data Available

Environmental data from a study to assess the potential effects of man-generated substances and activities on the marine environment is now available from the Commerce Department's National Oceanic and Atmospheric Administration.

According to NOAA's Environmental Data Service the data are from the Prediction of Ocean Pollutants Study conducted by the Ocean Affairs Board of the National Research Council which began in May 1973 with the identification of six substance types for study.

The substances were chosen because of their persistence, and abundance in the marine environment. They include nuclear wastes, synthetic organic chemicals, marine litter, metallic processing wastes from industrial operations, organic sludges, and medical and agricultural pharmaceuticals.

Information on each substance's basic chemical and physical properties, U.S. and foreign production, major uses, environmental leakages, routes through the environment, and potential effects on the environment were collected by ten NRC research associates during the summer of 1973. The collection of information, consisting of papers from scientific journals, tables, data, status reports from industry and government agencies, formal and informal reports, and referenced personal communications, has been indexed and is available through the Environmental Science Information Center, Marine and Earth Sciences Library (Fisheries Branch), 3300 Whitehaven Street, N.W., Washington, DC 20235.

Monitor Nominated As A "Marine Sanctuary"

The remains of one of the nation's most historic warships, the ironclad U.S.S. *Monitor*, and the ocean area where it has rested for more than 100 years have been nominated to become the country's first Marine Sanctuary.

Robert W. Knecht, Director of the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration, announced receipt of the nomination last fall from North Carolina Governor James E. Holshouser, Jr. The *Monitor* rests 220 feet beneath the surface of the ocean some 16 miles off Cape Hatteras, N.C.

In nominating the *Monitor* and its site as a Marine Research Sanctuary, Governor Holshouser cited both the historic and technological value of the Civil War gunboat. The *Monitor* is best known for its celebrated encounter with the Confederate ironclad ram, C.S.S. *Virginia*, popularly known as the *Merrimac*.

To ship builders, however, the *Monitor* represents a revolutionary concept in 19th century naval technology, symbolizing both the end of the wooden, sail-powered fighting ships and the beginning of the development of the modern capital ship.

Designation of the wreck site as a Marine Sanctuary will help to ensure that the *Monitor* is safeguarded and that archaeological research will be controlled, Governor Holshouser pointed out in his nominating letter.

Under the Marine Protection, Research and Sanctuaries Act of 1972, the Secretary of Commerce is authorized to designate marine sanctuaries to preserve or restore such areas for their conservation, recreational, ecological, or esthetic values. NOAA's Office of Coastal Zone Management is the government agency through which evaluations of marine sanctuaries nominations are conducted.

A discussion paper on the *Monitor* nomination was reviewed by the Department of Commerce, and a draft environmental impact statement—required for marine sanctuary sites—was developed for public release. A public hearing was also scheduled later in the year.

The *Monitor* foundered during a gale off Cape Hatteras on the last day of December, 1862, and sank with 16 of her crew onto treacherous Diamond Shoals. There the 172-foot warship rested, upside down and uncharted, for almost 111 years until the summer of 1973 when the wreckage was discovered by a marine research team using sonar and underwater photography techniques.

Early this year a more elaborately-equipped scientific expedition operating aboard the *Alcoa Seaprobe* confirmed the earlier find, obtaining hundreds of photographs of the wreckage and eliminating all doubt that it was, indeed, the *Monitor*.

Discovery and positive identification of the *Monitor* was a team effort on a large scale. Among those involved thus far have been scientists from Duke University's Marine Laboratory, the North Carolina Department of Cultural Resources, the National Science Foundation, the National Geographic Society, the U.S. Navy, Massachusetts Institute of Technology, the University of Delaware, and Aluminum Company of America.

Research Associate Will Study Squid Behavior

Brian J. Rothschild, Director of the NMFS Southwest Fisheries Center, La Jolla, Calif., has announced that Ann Hurley, animal behaviorist, is the latest recipient at the La Jolla Laboratory of a National Research Council Senior Research Associateship, awarded by the National Academy of Sciences and funded by the National Marine Fisheries Service, an agency in the U.S. Department of Commerce, National Oceanic and Atmospheric Administration. According to Rothschild, the annual award at the Center provides an opportunity for postgraduate scientists to work on basic research problems with professional staff at the laboratory.

During her 12 months at the La Jolla laboratory, Hurley plans to examine the importance of various types of visual stimuli on the schooling behavior of squid *(Loligo opalescens)* and will attempt to examine the development of schooling behavior using the facilities of the La Jolla Laboratory's saltwater aquarium where squid can be maintained. According to Hurley the squid is important in the pelagic food web off the California coast. It is a predator on many species of small fish and crustaceans and is itself a food item in the diet of larger fish, and marine mammals; the squid also increasingly serves as an abundant and nutritious protein source for man. The squid forms large schools in open water and migrates to shallow water to spawn, often in the vicinity of the La Jolla Laboratory. There is a small commercial fishery for squid in California and most biologists agree that it is presently an underutilized fisheries resource.

The mechanisms which cause squid to form large schools and to maintain their orientation within a school have not been studied, Hurley said. She thinks that vision probably provides the primary sensory input for schooling behavior and also appears to be important in other social interactions. She also noted that the survival value of schooling in fish has been considered but its use to squid or other pelagic invertebrates is unknown. Schooling in squid may be important as a mechanism to escape predators, or its main function may be to form breeding groups which migrate inshore to spawn. Hurley hopes that her work on comparisons of schooling in fish and squid may give clues to physiological mechanisms involved in schooling and the ecological importances of schooling to both groups of animals.

The first woman to receive a National Research Council Fellowship at the La Jolla Laboratory, Hurley, 27, is a graduate of Stanford University and received her Ph.D. in biological oceanography from the University of California, San Diego in 1972. Recently, Hurley held a position as a postgraduate research neuroscientist at the University of California, San Diego, where she conducted experiments to determine the feasibility of experiments on squid both on board ship and in the laboratory at the Scripps Institution. While on a three-week cruise aboard the University of California research vessel, *Alpha Helix*, she examined the mating behavior of *Loligo*, and has also observed spawning squid during scuba dives.

Malins, Stansby Get New NWFC Positions

Donald C. Malins has been appointed Director, Environmental Conservation Division, Northwest Fisheries Center, National Marine Fisheries Service, NOAA, Seattle, Wash. He succeeds Maurice E. Stansby who, as advisor to Center Director Dayton L. Alverson, now is Scientific Consultant on Contaminants Research, concentrating on petroleum hydrocarbons and their effects on marine life. Malins will supervise research in the fields of biology, biochemistry, physiology, and pathobiology.

NOAA Sea Grant Assists University of California Marine-Related Research

Continuing work to develop a commercially feasible lobster aquaculture program, commercial exploitation of the California squid fishery and further development of a dynamic floating breakwater for dissipating wave energy are major parts of the University of California Sea Grant program for which Commerce Secretary Frederick B. Dent announced a $1,631,000 grant last fall.

Headed by Jeffrey D. Frautschy of UC-San Diego, the program involves investigators from the University of California campuses at San Diego, Berkeley, Santa Cruz, Davis, and Santa Barbara; the Moss Landing Marine Laboratory; the California State University campuses in San Diego, San Jose, and Northridge; and the University of San Diego.

The grant was made by the National Sea Grant Program of the National Oceanic and Atmospheric Administration. Purpose of the program is to enhance the development of America's marine resources in the oceans, the Gulf of Mexico, and the Great Lakes. At least one-third of the funds for each Sea Grant project must come from non-Federal sources.

The major aquaculture work will continue to focus on the American lobster. Investigators at Davis and Bodega are concentrating on the development of closed systems using both natural and artificial seawater in order to obtain good control of all factors affecting the animals. The use of temperature control to achieve rapid growth, and research on problems of mass larval rearing and disease identification, control, and immunization will be emphasized at San Diego. The economic study for a scaled-up commercial venture will also be continued.

The breeding and growth cycles of the crab, *Scylla serrata*, will also be studied as a potential candidate species for aquaculture. It is a tasty, disease-resistant crab that grows to one and a half pounds in ten months and breeds and grows in confined spaces.

Rounding the aquaculture program are projects dealing with seaweed production, the ecology of the kelp forest, and the biology and breeding of salt-tolerant land plants possessing a potential for commercial crop raising in saline environments.

Commercial exploitation of the California squid fishery is the objective of a project new last year. Improved harvesting gear, better knowledge of spawn areas, and determination of sustainable yields are included in this many-faceted investigation. Continuing efforts for developing quick chemical assays of "red tide" toxins, improving seafood preservation methods, and determining impacts of various schemes for restricting entry to fisheries are planned.

Under the marine products program, the University will continue its efforts in the chemistry of marine-derived compounds which are active against marine bacteria and which demonstrate algae-inhibiting properties for application in antifouling agents. A new project will assess the interference that naturally halogenated compounds produce in present analytical techniques for determining pesticide levels. Since current pesticide analytical methods are incapable of distinguishing between natural and unnatural substances, many of the reported high levels of PCB's may in fact be due to high levels of naturally occurring compounds.

Two ocean energy related projects are included in the program. One, a continuing development of a dynamic floating breakwater for dissipating wave energy, may provide a less expensive way of protecting ships in harbors from wave damage. The second is a determination of the biological effects of waste heat effluent from the large electric power plant at Morro Bay.

Under the education program a practical on-the-job course will be continued in the technology of marine science at California State University, San Diego. The California advisory service program will employ a variety of methods to communicate research results to those who will apply them in properly utilizing the marine resources for managing the marine environment. Arrangements have been made for cooperation with other Sea Grant programs in the State under the joint designation of a California Marine Advisory Program.

U.S., France Extend Oceanic Cooperation

The United States and France have agreed to continue this year cooperative ocean programs begun in 1970, according to Robert M. White, Administrator of the Commerce Department's National Oceanic and Atmospheric Administration.

Plans were revealed by White on his return from a meeting of the U.S.-French Cooperation in Oceanography last fall at the Brest Center of Oceanology, the major laboratory of France's National Center for the Exploitation of the Oceans (CNEXO).

White and Yves LaPrairie, Director-General of CNEXO, termed the sessions a major step forward in international scientific cooperation. In a joint statement, the oceanic leaders described as a highlight of the year the French-American Mid-Ocean Undersea Study (Project FAMOUS), whose field phase was recently completed.

In Project FAMOUS, after three years of planning and preparation, some 50 manned investigations to depths of 3,000 meters in the Mid-Atlantic Ridge southwest of the Azores were conducted by the U.S. submersible *Alvin* and France's *Cyana* and *Archimede*. The dives provided, for the first time, direct observations

by man advancing the concepts of continental drift and the scientific theories of plate tectonics. The scientific data acquired will be analyzed, and a bilingual report prepared.

New exchange activities have been initiated in marine pollution investigation. The nations will examine techniques for controlling oil discharges from ships. Another joint effort will study remote surveillance systems for response and enforcement against ships discharging oil, as prohibited by national and international conventions. Working with CNEXO to develop technical symposia and demonstrations in airborne surveillance systems will be the U.S. Coast Guard.

A new area of cooperation initiated at Brest provides for research in coastal processes. Industrial development along the coasts has accelerated greatly in recent years, and the U.S.-French research will be designed to help assure environmentally acceptable patterns of development.

Other significant continuing efforts concern the development of buoys and associated sensors for monitoring the ocean environment, aquaculture, instrumentation standardization and comparability, and such vital aspects of man-in-the-sea as diving safety and physiology.

White and LaPrairie also agreed to examine possibilities for cooperation in additional plate tectonics studies involving further use of submersibles, and methods of converting wind and temperature differences, currents and tides to useful energy.

Foreign Fishery Developments

Japanese Foreign-Based Skipjack Fishery Develops in South Pacific

Japanese fishery firms conducting skipjack tuna fishing in the South Pacific jointly with foreign partners had good catches last year.[1] Taiyo's vessels based in the British Solomons, and the Papua New Guinea-based fishing fleets, operated by Kyokuyo (which was having Daido Suisan manage the operations), Hokoku Suisan and Kaigai Gyogyo, were expected to attain their catch targets set for 1974. The good fishing experienced brightened the outlook for establishing a skipjack fishery in the southwest Pacific. The Papua New Guinea-based fishing operations were conducted experimentally in accordance with the plan to establish a fish cannery at Madang, for which the Papua New Guinea Canning Company was formed in 1972 jointly by the Japanese fishery firms, a U.S. tuna packer, and an investment firm in Papua New Guinea.

Solomon Taiyo is a jointly operated fishing venture based in the British Solomons. This company, formed one and one-half years ago, operated ten pole-and-line vessels (mostly of wooden construction). The fleet, based in Tulagi, fared well, as can be seen from its catch of 1,200 tons in June, 1,500 tons in July, and 1,200 tons in August. The catch goal for 1974, set at 10,000 tons, was expected to be easily surpassed. Most of the catch was frozen for export to the United States. Two ferro-concrete boats of 50 gross ton size were scheduled to be added to the fleet by March 1975. These boats, being built in Japan at a cost of 50 million yen (US$166,700 at 300 yen = US$1) each, will be the first Japanese-built fishing boats of ferro-concrete construction.

At Tulagi, the joint company operates an 800-ton capacity cold storage, built in August 1973, and a tuna cannery with production capacity of 1,300 cases/day, constructed in October that year. While the cannery was packing 500 cases a day in mid-1974, production was expected to increase as the local employees gained experience. "Katsuobushi" (dried skipjack loin) production, temporarily suspended earlier in 1974, was resumed in July and the daily output in September was 5 tons (converted to raw fish).

Gollin Kyokuyo was established in Kavieng jointly by Kyokuyo and Australian interests. This venture operated 11 Okinawan pole-and-line boats (39 gross ton in size) which, as in 1973, experienced good fishing. Their combined three-month catch to 31 July was over 5,000 tons. At that rate, it was expected that they would soon reach their catch goal of 10,000 tons set for 1974. Fifteen percent of the landings were processed into "katsuobushi," and 85 percent were frozen and exported to the United States.

New Guinea Marine Products is a joint skipjack fishing venture formed in Madang by the Japanese fishery firm Hokoku Suisan and an Australian firm. Fishing by this venture was reported to be good in 1974 compared with 1972 and 1973, when results were unfavorable. Fish landings by two motherships and nine catcher vessels had reached 5,200 tons in September and the catch goal for 1974 was 6,000 tons.

Carpentaria Kaigai is a joint venture company based in Rabaul. This company was operating 14 skipjack vessels (mostly 39-ton Okinawan pole-and-line vessels) in September 1974. Favored by good fishing conditions, the fleet, which began fishing conditions, the fleet, which began fishing in April, was catching 1,200-1,300 tons/month. The skipjack landings were frozen and exported to the United States. Until the cannery planned for construction in Madang is completed, all the skipjack catch will be frozen for export to the United States.

Source: *Suisan Keizai Shimbun, 18 Sept. 1974.*

[1]See also, Kearney, R. E., "Skipjack Tuna Fishing in Papua New Guinea, 1970-73," page 5.

VIBRIOSIS HITS NORWEGIAN FISH

Many thousands of young saithe were found dead or dying along the coast of western and central Norway in mid-October 1974 reports Norinform. The fish, most of which belong to the 1973 class, are victims of the bacterial disease vibriosis. It is reported to be too early to say what effect these deaths will have on the stocks of saithe, an important fishery in Norway. Although the 1973 class is large, it is feared that considerable losses may nevertheless be recorded. There have also been reports that other fish species have been hit by the disease, but the Institute of Marine Research in Bergen has so far been unable to confirm this. Species

reputed to be affected include cod, plaice and eels, though only in small numbers if at all. If the disease spreads to the whole of northern Norway, the effect on stocks could be serious.

No cause is known for the sudden outbreak, though the Institute of Marine Research has suggested in a statement to the press that the size of the class itself, as well as special environmental factors such as pollution, may be responsible. Vibriosis, one of the earliest diseases of fish to be recorded, is endemic among saithe, and mass deaths such as the present have been recorded from time to time, the last being in 1967.

USSR Holds Meeting on Commercial Fish

In March 1974, a nationwide conference of Soviet scientists was held in Murmansk to discuss the biology of commercial fish and invertebrates at early stages of development. It was organized by the N. M. Knipovich Memorial Polar Scientific-Research Institute of Marine Fisheries and Oceanography (PINRO), the Northern Fisheries Administration Department of the Ichthyological Commission, and the Murmansk Department of the All-Union Hydrobiological Society.

Participating in the conference were 115 specialists from research institutes of the USSR Ministry of Fisheries, the USSR Academy of Sciences, and various universities. About 150 papers were presented on such topics as: composition year-classes of commercial fish stocks, factors determining survival at early stages of ontogenesis, and the effect of the age and the condition of spawners on the viability of gametes and young fish. Many reports dealt with various aspects of artificial reproduction of fish in inland waters, as well as problems in a new field—marine aquaculture.

There has been a noticeable increase in both the number and the complexity of investigations into the early life of commercial fish and invertebrates, in particular physiological-biochemical investigations into the early stages of ontogenesis of marine and freshwater fish. Knowing these stages is extremely important for long-term forecasting of fish populations.

The conference revealed the practical problems that must be solved by further investigations into the early stages of fish development such as: perfecting existing methods and finding new methods for forecasting the status of fish stocks; developing methods for regulating fisheries on the basis of determining and quantitatively expressing the link between the stock and recruitment; working out the principles of marine aquaculture and perfecting freshwater aquaculture; and determining the necessary recruitment parameters for utilization in automatic control systems by the fishing industry.

Considering the enormous scientific and practical importance of investigations in this field, the conference passed a resolution stressing the need for specialized ichthyoplankton laboratories within the research institutes of the Ministry of Fisheries.

Participants in the conference also suggested creating a council attached to the Ichthyological Commission to coordinate investigations into the early stages of ontogenesis of commercial fish and invertebrates.

Source: *Rybnoe Khoziaistvo*, June 1974.

Experimental Cuban Boats Seek Shrimp and Lobster

A flotilla of experimental vessels built in Cuban shipyards for catching shrimp and lobster has set out on its first fishing expedition. The 20-meter vessels are constructed of steel-reinforced concrete and are intended for coastal fishing in the region of the Gulf of Guacanayabo and south of Camaguey province. The nine fishing vessels are equipped with modern navigation and fishing gear. Such Cuban-built vessels, as well as vessels bought from Peru, will soon begin to catch shrimp and lobster in other coastal waters of Cuba. Ships of this flotilla, which are capable of cruising on the high seas and of operating in conjunction with special refrigerated trawlers, characterize a qualitatively new stage in the development of the Cuban fishing fleet. In time they will fully supplant the inefficient fishing craft.

Source: *Ostsee Zeitung*, 18-19 May 1974, East Germany.

Japan and Russia Agree to International Observation for 1974-75 Whale Season

Japan and the Soviet Union, on 13 September 1974, signed an agreement in Tokyo to continue, as in the previous season, the international observer scheme for the 1974-75 Antarctic whaling operations. The agreement, to be effective until 31 August 1975, provides that the two governments will designate international observers (to be formally appointed by the International Whaling Commission), one for each factoryship of the other country. The observers will be maintained to ensure compliance with the terms of the International Whaling Convention.

Boarding costs will be paid by the country dispatching the observers. The Japanese and Soviet representatives, at the same meeting, also signed the agreement initiated earlier concerning allocations of the international whale catch quotas by regions established by the International Whaling Commission for the 1974-75 Antarctic whaling season.

Sources: *Minato Shimbun and Suisan Tsushin.*

Japan-USSR catch quota allocations for 1974-75 whaling season.

Whale species	Number of whales				
	Japan		USSR		Total
Antarctic Ocean (1974-75)					
Fin	598	[1](867)	402	(583)	1,000
Sei	2,392	(2,632)	1,608	(1,768)	4,000
Minke	3,500	(4,000)	3,500	(4,000)	7,000
Sperm					
Male	1,196	(1,200)	4,985	(5,000)	[2]8,000
Female	683	(690)	2,871	(2,900)	[2]5,000
North Pacific Ocean (1974-75)					
Fin	134	(246)	166	(304)	300
Sei	1,345	(2,017)	655	(983)	2,000
Sperm					
Male	2,565	(2,565)	3,435	(3,435)	6,000
Female	1,710	(1,710)	2,290	(2,290)	4,000

[1]Figures within parentheses denote 1974 allocations.
[2]Includes allocations to Australia, South Africa, and Brazil.

Canada's Fishermen Get Ice Damage Compensation

Details of a compensation program to share in the cost of reimbursing Newfoundland fishermen for destroyed or damaged fishing gear and equipment caused by abnormal ice conditions in 1974 were announced jointly by the Federal Minister of State (Fisheries) Roméo LeBlanc and Newfoundland Fisheries Minister Harold Collins.

The Federal cabinet approved use of the peacetime disaster formula to compensate for the gear loss and damage, estimated at $3 million. Under this formula, the estimated Federal share will amount to 53.9 percent, or $1.62 million, and the Provincial contribution will be 46.1 percent, or $1.38 million.

So severe were ice conditions off the coasts of Newfoundland and Labrador last year that normal fishing operations were delayed 2 months or more. When conditions improved and fishermen finally were able to set their nets and traps, constantly shifting ice wreaked havoc with the gear. All of the fishing gear used off the coast of Newfoundland was fixed (i.e. anchored) rather than towed, and was particularly vulnerable to damage or loss by shifting ice.

Estimated losses include 80,700 lobster traps, 1,800 salmon gill nets, and 300 cod traps. Other gear lost or damaged included lumpfish nets, cod and herring gill nets, anchors, buoys and radar reflectors. The situation has been declared a disaster by the Government of Newfoundland.

Administration of the joint compensation program will be handled by the Province, which will also be responsible for enumerating and evaluating the claims. Under the Federal Government's peacetime disaster formula, Federal participation occurs when losses exceed $1 per capita of provincial populations. As losses increase the Federal share applies on an increasing percentage basis, as follows:

Losses per Province Eligible for Sharing (per capita)	Federal Share
First $1	0
Next $2	50%
Next $2	75%
Remainder	90%

Norway Seeks Partial Cod Trawling Ban

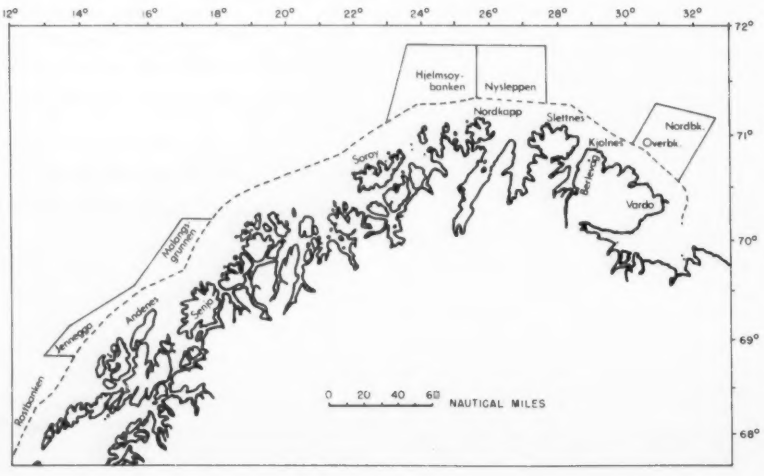
Norway will seek the establishment of four zones in the waters beyond the 12-mile fisheries limit off northern Norway from which trawling for cod will be banned for part of the year, reports Norinform. The four areas in question cover Jennegga and Malangsgrunnen off Vesterålen, Hjelmsøybanken off West Finnmark, Nyslepen off West Finnmark and Nordbanken and Østbanken off East Finnmark. The zone off Vesterålen, where the ban is to operate from 1 October to 30 April, extends from 4 to 19 nautical miles beyond the 12-mile limit. The two adjacent zones off West Finnmark extend from 27 to 33 nautical miles from the 12-mile limit, while that off East Finnmark extends from 27 to 42 nautical miles beyond the 12-mile limit—which means that it reaches out beyond a future 50-mile fisheries limit in places. The ban on trawling in the latter three zones is to last from 1 October to 31 March.

This was announced 24 October 1974 by the Minister responsible for fisheries limits questions, Jens Evensen, at a press conference in Oslo. Evensen explained that the zones chosen are ones in which there have been a large number of collisions between trawlers and passive fishing gear (such as long lines or drifting nets) put out by coastal fishermen, or where coastal fishermen have been driven off traditional fishing banks by trawlers. The zones are intended primarily to protect the coastal fisherman and his gear from loss, rather than to conserve fish stocks. They are regarded as a first step towards an extension of the fisheries limits to 50 nautical miles and the eventual establishment of an economic zone stretching out 200 miles from the coast.

The proposed zones cover a total area of 5,300 nautical square miles, or about 20 percent of the area between the present 12-mile fisheries limit and a future 50-mile limit off northern Norway between Skomvær in Lofoten and the boundary with the Soviet Union.

The zones are to be created on a nondiscriminatory basis. In other words, both Norwegian and foreign trawlers are to be excluded. Only trawling for cod is involved. Trawling for other species, including, for instance, the capelin fishery off Finnmark, is not to be covered by the ban, the Ministry of Fisheries has made clear.

Evensen has recently been on a tour of Western European capitals and Moscow to explain the Norwegian proposals with regard to the fisheries limits and the no-trawling zones. On the map of northern Norway left the broken line shows the existing 12-mile fisheries limits, and the solid lines enclose the four proposed no-trawling zones.



NORWAY'S 1973 WINTER COD CATCH DECLINES

Norway's 1973 catch of spawning cod amounted to only 113,000 metric tons, a decline of 41 percent from the 1972 figure of 193,000 tons reports the NMFS International Fisheries Analysis Division. Between 1970 and 1974 the annual take of capelin had been between 1.3 and 1.5 million tons, but this year a reduced quota of 700,000 tons was established to pre-

vent a serious depletion of the resource. Scientists accurately predicted catch declines by analyzing each species by year classes since the early 1960's, but Norwegian fishermen tended to reject such dire predictions.

Overfishing of young cod and capelin is generally blamed for the current shortages, but some recovery in these fisheries is predicted by 1976 or 1977, unless heavy fishing of the Barents Sea by Soviet, British, and other trawlers continues unabated.

In the mid-1960's Norway's herring fishery also slumped badly due to overfishing, so a switch was made to the capelin resource. Both species were used primarily for reduction to meal, but recently Norway has joined other nations in proclaiming that herring is too important for human consumption to be used for reduction purposes.

As the capelin resource has declined, research interest in the catch of blue whiting has increased greatly. It is estimated that this resource could provide an annual yield of 500,000 to 1,000,000 metric tons, most of which would be used for reduction purposes or for minced products. Currently blue whiting accounts for about 20 percent of the catch listed under the generalized category of "Norway pout."

According to the NMFS International Fisheries Analysis Division, Norway currently appears to be predisposed toward acceptance of a 200-mile Fishing Zone, and unrestricted trawling off her coastline will do nothing to lessen her conviction that such an extension is absolutely necessary to preserve her fishery resources.

Publications

Polish, Yugoslavian, Russian, German, and Italian Fishery Translations Are Available

A limited number of the following Polish, Russian and Yugoslav publications translated and printed for the National Marine Fisheries Service (NMFS) under the Special Foreign Currency Science Information Program (financed with Public Law 480 funds) are available for free distribution from the Language Services Division, F43, Office of International Fisheries, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235. Please request by translation (TT) number.

Translation numbers, titles, and authors include: TT 66-57049, Technological and chemical characteristics of the North Atlantic redfish, Hryniewcka, K.; TT 66-57050, Statistics of Polish fisheries in 1961, Kazmierski, K., et al.; TT 66-57054, Economic foundations of Polish sea fisheries development, Lasczynski, S.; TT 66-57055, Polish fishery statistics in 1920-1960, Lasczynski, S.; TT 66-57056, Separation of fish flesh amines by the modified Steiner-Kamienski method, Minakowski, W., and O. Rzewuski.; TT 66-57058, Trawler operation in the North Sea, Noetzel, B.; TT 66-57059, Method of examination of yield of catches of a fishing fleet on distant fishing grounds, Orlowski, J.; TT 66-57060, Psychosociological problems of work in the fisherman's occupation, Polanska, A.; TT 66-57063, Preliminary examination of the operation of B-23 trawlers on fishing grounds of the northwest Atlantic shelf, Swiniarski, J.; TT 66-57064, Effect of thermal denaturation on the mechanical resistance and texture of animal tissue (Baltic herring), Tilgner, D.J., and B. Markowski; TT 66-57065, Mechanical resistance of fresh Baltic herring, Tilgner, D.J., and B. Markowski; TT 66-57066, Chemical and weight composition of fish. II. Edible parts and offals of *Coregonus albula* L., Ziechik, M., and J. Zamojski; TT 66-57067, Chemical and weight composition of fish. I. Edible and inedible parts and gonads of flounder, Ziecik, M., and J. Nodzynski; TT 66-57068, Variable factors in the production of canned sprat in relation to labor productivity, Ziemba, Z.; TT 66-57069, Frozen fish as raw material for the processing industry (1959 data), Zukowski, K.; TT 71-50120, Automation of navigation and tactical control in fishing, Ol'khovskii, V. E., et al.; TT 71-50128, Soviet fisheries investigations in the Indian Ocean, Bogdanov, A.A. (editor); TT 71-50129, Theory and design of commercial fishing gear, Fridman, A. L.; TT 71-50130, Fauna of the Kurile-Kamchatka trench and its environment, Bogorov, V.G. (editor); TT 72-50035, Life activity of pelagic communities in the ocean tropics, Vinogradov, M.E. (editor); TT 71-50019, Chemistry and technology of Pacific fish, Kizevetter, I.V.; TT 70-55125/8, 9, Marine Technology and Management, Vol. 20, Nos. 8, 9; TT 70-55125/12, Marine Technology and Management, Vol. 20, No. 12; TT 70-55126/5, 6, Shipbuilding, Vol. 15, Nos. 5, 6; TT 77-55126/11, 12, Shipbuilding, Vol. 15, Nos. 11, 12; TT 60-21144, State of Stocks and means of increasing the number of Amur pink salmon, Abramov, V.V.; TT 60-21150, Age of pink salmon and the pattern of their fluctuations in abundance, Vedenskiy, A.P.; TT 60-21865, Technology of fish processing, Styr, J.; TT 60-51041, Population dynamics and the state of the chum and pink salmon stocks in the Amur River basin, Birman, I.B.; TT 60-51129, Some suggestions on the standardization of Far Eastern trawls, Lestev, A. V., and G. Ye. Grishchenko; TT 61-11367, Thrusting implements for fishing (archeological study), Znamierowska-Pruffer, M.; TT 64-11101, Bibliography of literature on fisheries of the Far East, 1923-1956, Romanov, N.S.; TT 65-50097, Annotated bibliography on fisheries of the southern basins of the U.S.S.R., 1918-1953, Romanov, N.S.; TT 65-50365, Chlorophyll in the seston of certain Polish lakes as an indicator of productivity, Solski, A.; TT 65-50368, Hydrographic observations in the southern Baltic in 1953-1955, Filarski, J.; TT 65-50503, Selected translations from Roczniki Nauk Rolniczych (Polish publication); TT 66-51047, Parasites of the fishes of the Barents Sea, Polyanskii, Yu. I.; TT 66-57048, Sprat freezing with the use ascorbic acid and alginian gel, Gora, A., and P. Trzesinski.

ICCAT PAPERS TRANSLATED

"Albacore populations in the northeast Atlantic," by H. Aloncle and F. Delaporte, 78p.; "Some data on bluefin tuna (*Thunnus thynnus L.*) fishing

in the North Atlantic," by J.C. Dao and C. Bessineton, 16p.; "Representation of spatio-temporal groupings on the basis of statistics of parasite infestation in the Atlantic yellowfin (*Thunnus albacares*). First results obtained through a factorial analysis of correspondences," by F. Baudin Laurencin, 18p.; "Comparative fishing efficiency and evolution of the effort of the tuna boats of the French-Ivory Coast-Senegal fleet exercised on the various sizes of Atlantic yellowfin tuna," by A. Fonteneau and A. Caveriviere, 15p.; "Application of Schaefer model and derivatives to the Atlantic yellowfin (*Thunnus albacares*) populations," by A. Fonteneau and A. Caveriviere, 40p. The above papers presented at the Fourth Meeting of the Permanent Committee for Research and Statistics (SCRS), International Commission for the Conservation of Atlantic Tunas (ICCAT), November 19-24, 1973, Paris, have been translated in Tunisia for the National Marine Fisheries Service under the Special Foreign Currency Information Program (financed with PL-480 monies). Aloncle and Delaporte establish heterogeneity of the albacore stock in the northeast Atlantic, based particularly on 1971-72 tagging research. Dao and Bessineton studied Atlantic bluefin catch data and suggest that a larval concentration may exist off Morocco and Mauritania, as they found a concentration of young fish in this area, quite far from known spawning grounds. Laurencin uses factorial analysis of data on parasitic infestation of yellowfin to distinguish among stocks, noting two stocks, north and south respectively, in the Gulf of Guinea, and a third stock in the sea off Antilles. Fonteneau and Caveriviere analyze catch statistics for Atlantic yellowfin tuna since 1969, showing greatly increased fishing effort on the larger yellowfin, somewhat less on 2-4 year-class yellowfin, and relatively unchanged pressure on the small yellowfin. The second Fonteneau-Caveriviere paper applies the Schaefer-type model to Atlantic yellowfin stocks and estimates fishing effort, 1960-1972, in the eastern tropical Atlantic fishery, to give an average MSY of approximately 50,000 metric tons, signalling the need for a catch quota in the near future. The translations are available on loan from the Language Services Division, F43, Office of International Fisheries, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235.

POLISH PROCEEDINGS

The following five articles from the Fiftieth Anniversary Volume of the Polish publication, Proceedings of the Sea Fisheries Institute, 1971, were recently translated in Poland for the National Marine Fisheries Service (NMFS), NOAA, under the Special Foreign Currency Science Information Program (financed with Public Law 480 funds). They are available on loan from the Language Services Division, F43, Office of International Fisheries, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235.

"Studies on selectivity of trawls as a factor in ensuring Polish fisheries interests in the north Atlantic," by W. Strzyzewski, 38p. Tests were conducted in the Baltic and North Seas and in the north Atlantic by Polish researchers interested in selectivity of trawl gear, especially in the cod and herring fisheries. Coefficients of selectivity were calculated for codends constructed of various nets and fibers and surrounded by covers and chafers to prevent tearing the codend on the slipway when hauling gear, and a knotless chafer was developed which protected the codend but still allowed high selectivity.

"Progress in the development of processing by Polish fishing vessels in 1945-1970," by E. Kordyl, 37p. Kordyl traces technological and strategic developments in the Polish fisheries, from their concentration on the Baltic and North Seas to their expansion into the North Atlantic, and some of the reasons for these developments.

"Economic consequences of the expansion of the fishing range," by Z. Polanski, 31p. Polanski discusses the various factors determining the value of catch per unit of fishing effort during expansion of the fishing range. He concludes that technology is the primary factor: expansion of the range accompanied by technological improvements will tend to cause unit cost to drop, whereas without those improvements unit cost will tend to rise.

"Problems of fish refrigeration in economic works of the Sea Fisheries Institute," by K. Zukowski, 22p. This is a survey of the results of research conducted at the Sea Fisheries Institute on the refrigeration of catch. It compares developments in refrigeration technology in Poland with that in other countries. Zukowski's particular concern is for coordination of refrigeration technology with other aspects of the fisheries economy.

"Research on fish resources on the fishing grounds of Nova Scotia and New England," by B. Draganik, 60p. This presents results of Polish research into fish stocks in ICNAF subareas 4, 5, and 6 in 1964-1969. It includes Polish catch statistics for certain species and calculations of fishing effort and CPUE. Species investigated include herring, haddock, argentine, mackerel, butterfish, blueback, alewife, silver hake, and squirrel hake.

"Type ranges of benthic invertebrates and the biogeography of South American temperate waters," by V.N. Semenov, Wealth of the World Ocean, (P.A. Moiseev, editor), No. 2, Proceedings of the All-Union Scientific Research Institute of Marine Fisheries and Oceanography, Vol. 77, 1972, p. 120-152. Semenov reviews data leading to classification of faunal ranges of the South American continental shelf and on the basis of this identifies 24 type ranges, in 4 distinct groups: warm waters, warm-temperate waters, temperate waters, and cold-temperate waters. Rather than diversity indices, indicator species are used to delineate the type ranges. Although this classification is restricted to horizontal distribution, Semenov is able to make some general statements about correlation with the vertical. After proposing the type ranges, he discusses their characteristics in some detail, noting particularly their relative importance. He stresses transitional areas, especially where two ranges overlap to a considerable extent. The translation was done in Israel for the National Marine Fisheries Service under the Special Foreign Currency Science Information Program (financed with PL-480 funds).

It is available on loan from the Language Services Division, F43, Office of International Fisheries, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235.

GERMAN, ITALIAN VOLUMES

The following two German and one Italian fishery publications produced by the Naples Zoological Station, Naples, Italy, were translated and printed in Israel in 1972 for the Smithsonian Institution under the Special Foreign Currency Science Information Program (financed with PL-480 funds): "Fauna and Flora of the Bay of Naples," Monograph No. 35, "Cephalopoda," by Adolf Naef, 1921/1923, Part I, Vol. 1, Fascicle 1, 292 pp., TT 68-50343/1, and Part I, Vol. 1, Fascicle 2, 625 pp., TT 68-50343/2; and "Fauna and Flora of the Bay of Naples," Monograph No. 38, "Eggs, Larvae and Juvenile Stages of Teleostei," by Salvatore Lo Bianco, Parts I and II, 1931-1933, 417 pp., TT 68-50346. The Smithsonian was unable to obtain the copyright release at the time the translations were issued. Thus they were printed in a very limited number of copies and no outside distribution was made. The National Technical Information Service (NTIS), Springfield, VA 22151, has recently received the authorization to enter the three volumes into its system. The cost per xeroxed copy is as follows: TT 68-50343/1 — $6.75; TT 68-5034/2 — $13.00; and TT 68-50346 — $8.50. Foreign requesters will have to add $2.50 per copy for postage. Checks should be made payable to NTIS and orders must include the translations' accession numbers.

RUSSIAN BOOKS

"Whales and dolphins," by A. V. Iablokov, et al, Nauka publishers, 1972, 472p. This book, translated by the U.S. Joint Publications Research Service, is a broad but thorough survey of the behavior and functional anatomy of cetaceans. It is designed to provide basic information on cetaceans for researchers in all areas of biology and applied sciences. While it covers all of the cetaceans, there is considerable emphasis on current studies of dolphins, as more meaningful generalizations may be drawn from the larger number of dolphins examined. It includes a comprehensive current bibliography and over 200 figures. The translation in two volumes, is available on loan from the Language Services Division, F43, Office of International Fisheries, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235. It can be purchased from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151. The first volume, JPRS 62150-1, is $6.50; the second volume, JPRS 62150-2, is $6.75 (total $13.25). On microfiche, the price is $1.45 per volume. If ordering from overseas, there is an additional mailing charge of $2.50 per volume. Please cite accession numbers when ordering.

"The world ocean," by A.L. Kolodkin, Mezhdunarodnoe otnosheniia publishers, 1973, 232p. This book, translated by the U.S. Joint Publications Research Service, discusses problems in the international legal regime of the sea, and in particular the policy of the U.S.S.R. concerning problems of the sea bed, territorial waters, and conservation of the marine environment as it has been revealed through scientific conferences and governmental action and doctrine. The translation, 107p., is available on loan from the Language Service Division, F43, office of International Fisheries NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235. It can be purchased for $4.50 from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151. On microfiche, the price is $1.45. If ordering from overseas, there is an additional mailing charge of $2.50 per volume. Please cite accession number JPRS 60963 when ordering.

Recent NMFS Scientific Publications

NOAA Technical Report NMFS SSRF-679. Wing, Bruce L. **"Kinds and abundance of zooplankton collected by the USCG icebreaker Glacier in the eastern Chukchi Sea, September-October 1970."** August 1974. 18 p.

ABSTRACT

Zooplankton samples were taken at 39 oceanographic stations in the eastern Chukchi Sea in September and October 1970. Sampling was done by vertical tows from near bottom to the surface with a 0.5-m diameter No. 0 (0.57 mm) mesh NorPac standard plankton net. Data are presented on the distribution and relative abundance of 63 categories of zooplankton at the onset of winter. Zooplankton abundance generally was lowest in waters with temperatures below 0°C; it did not appear to be associated with the distribution of salinity; and it tended to be inversely related to dissolved oxygen concentration. Comparison of zooplankton abundance in 1970 with published observations on the Chukchi Sea in 1947 shows probable seasonal variation of meroplankton abundance and yearly variation of holoplankton abundance.

NOAA Technical Report NMFS SSRF-680. Sanger, Gerald A. **"Pelagic amphipod crustaceans from the southeastern Bering Sea, June 1971."** July 1974. 8 p.

ABSTRACT

Fourteen species of pelagic amphipods were present in zooplankton samples collected from the southeastern Bering Sea in June 1971. *Parathemisto pacifica* strongly dominated relative abundance (68-96 percent) and was present in numbers up to an estimated 2,755/1,000 m^3 of water. *Primno macropa* was the only other species present in all hauls and ranged from 4 to 27 percent in relative abundance. *Cyphocaris challengeri* was present in numbers up to 48/1,000 m^3 during night hauls, but only one animal was taken in all daylight hauls. *Hyperia medusarum* was present in 14 (82 percent) of the hauls but accounted for less than 1 percent of the total numbers.

A presumed diurnal vertical migration was evidenced for *Primno macropa*, *Cyphocaris challengeri*, and possibly for *Scina rattrayi*, *Hyperoche medusarum*, and *Hyperia medusarum*.

The occurrence of *Scina stebbingi*, *S. rattrayi*, *Vibilia caeca* (?), *Paraphronima crassipes*, *Phronima sedentaria*, and *Primno macropa* extended their known ranges in the Bering Sea eastward, and the occurrence of *Cyphocaris anonyx* represents a new record for the Bering Sea.

Oyster Reefs, Swordfish, and Gravel Incubators

. . . . Some 18 acres of **new public oyster reefs constructed in Florida's Dixie County** by the Division of Marine Resources last summer are expected to be harvestable by spring 1975. Approximately 1,600 tons of a mined limestone aggregate were used as cultch material, according to *Florida Conservation News*. Continued statewide oyster reef construction and rehabilitation is planned. . . .

. . . . **Dr. Roger D. Anderson has been named** head of the Department of Advisory Services of the Virginia Institute of Marine Science, the institution reports. Anderson has been assistant director of the Center of Marine Resources at Texas A&M University, College Station, Tex. He will administer VIMS' field extension and advisory activities. . . .

. . . . **Use of spotter airplanes by California's commercial swordfishermen** will be allowed at least two more years, according to the Fish and Game Commission. Airplane use beyond 1976, however, will depend on results of a DFG study of swordfish status and the effects of airplane spotting. An immediate ban on air spotting had been proposed by the DFG, while air proponents recommended a quota system if swordfish proved to be in danger. . . .

. . . . Young **blueback herring, alewives, American shad, and hickory shad were sampled** in Virginia's James, York, Potomac and Rappahannock Rivers late last summer by biologists with Virginia Institute of Marine Science. The VIMS and NMFS funded study provides data for estimating the number of young fishes produced in 1974. Prediction of stocks available for the commercial fishery are based on the data. . . .

. . . . **Prototype gravel salmon incubators** at Crooked Creek on Alaska's Kenai Peninsula have produced nearly half a million sockeye and silver salmon fry during the first year of operation, reports the Department of Fish and Game. Operated by the Division of Fisheries Rehabilitation, Enhancement, and Development (FRED), the facility is designed to enhance Cook Inlet salmon stocks. It began operation over a year ago (December 1973) with 1.3 million sockeye eggs in 16 incubators. In July 350,000 sockeye fry and 40,000 coho fry were transplanted. . . .

. . . . **Brine Shrimp could provide fish food and crop fertilizer** while keeping algae in a continuous state of exponential growth in sewage, according to *Science and Engineering News* (NOAA). Meanwhile, such sewage components as phosphates could be reduced to levels similar to those from conventional secondary or possibly tertiary treatment. . . .

. . . . **Crab farming may bolster diminishing Dungeness crab supplies,** reports *Sea Grant 70's*. In a 3-year Humboldt State University study, crabs on a "natural" bottom of sand and oyster shell thrived on Dover sole and shrimp discards. Early maturity, good flavor, and lower mortality were noted, and crab culture economics is now being eyed . . .

. . . . **A joint U.S.-USSR board to resolve claims of damage** to U.S. vessels or gear by Soviet vessels off U.S. coasts has begun work in Washington, D.C. Normally, parties may bring claims before the board within one year after a relevant incident, says NMFS Director Robert W. Schoning, though a provision allows discussing claims for incidents that occurred as early as February 1971. . . .

. . . . Production and dollar value of **landed fish from the Great Lakes gained in 1973,** according to NMFS statistics in the *Great Lakes News Letter*. The catch totalled 111.4 million pounds, 15 percent above 1972 poundage and the highest since 1969. Landed value gained 23 percent over 1972 to $17.7 million. Production from 1972 to 1973 rose in most areas of the lakes while minor declines occurred in the Canadian sections of lakes Ontario and Superior and the U.S. waters of Lake Huron. Lake Erie again led, with a landed fish value of $8.5 million, 48 percent of the total, and a catch of 48.2 million pounds, beating Lake Michigan for the first time since 1969. . . .

. . . . **A year-long American lobster study off Virginia's coast** by the Virginia Institute of Marine Science under a $41,000 NMFS contract, seeks data for estimating relative abundance, growth rates, dependence or independence of the stocks, and establishing a minioum legal size, according to VIMS scientists. . . .

. . . . **The crown-of-thorns starfish is probably still moving southward** on Australia's Great Barrier Reef according to a preliminary survey report in *Australian Fisheries*. Of 14 reefs reported clear of the starfish in 1970, three had large and widely-distributed starfish populations and a large aggregation was found in one small area of a fourth. . . .

. . . . **Successful completion of a two-year buoy test program** in the Arctic ice pack has been announced by NOAA. Seven 340-pound drifting buoys were emplaced, three of which operated 1½-2 years. A more sophisticated Arctic data buoy prototype is being developed and better weather forecasting and safer navigation is hoped for. . . .

. . . . **Instruments which may help answer questions about the size and speed of waves,** their effecss on weather and pollution, and their impact on the shore, and coastal and offshore structures, are being tested by NOAA's National Ocean Survey. Items tested range from bottom-mounted acoustic devices to large, vertically oriented electrical cables and include a wave measuring system on a deep-ocean buoy . . . .

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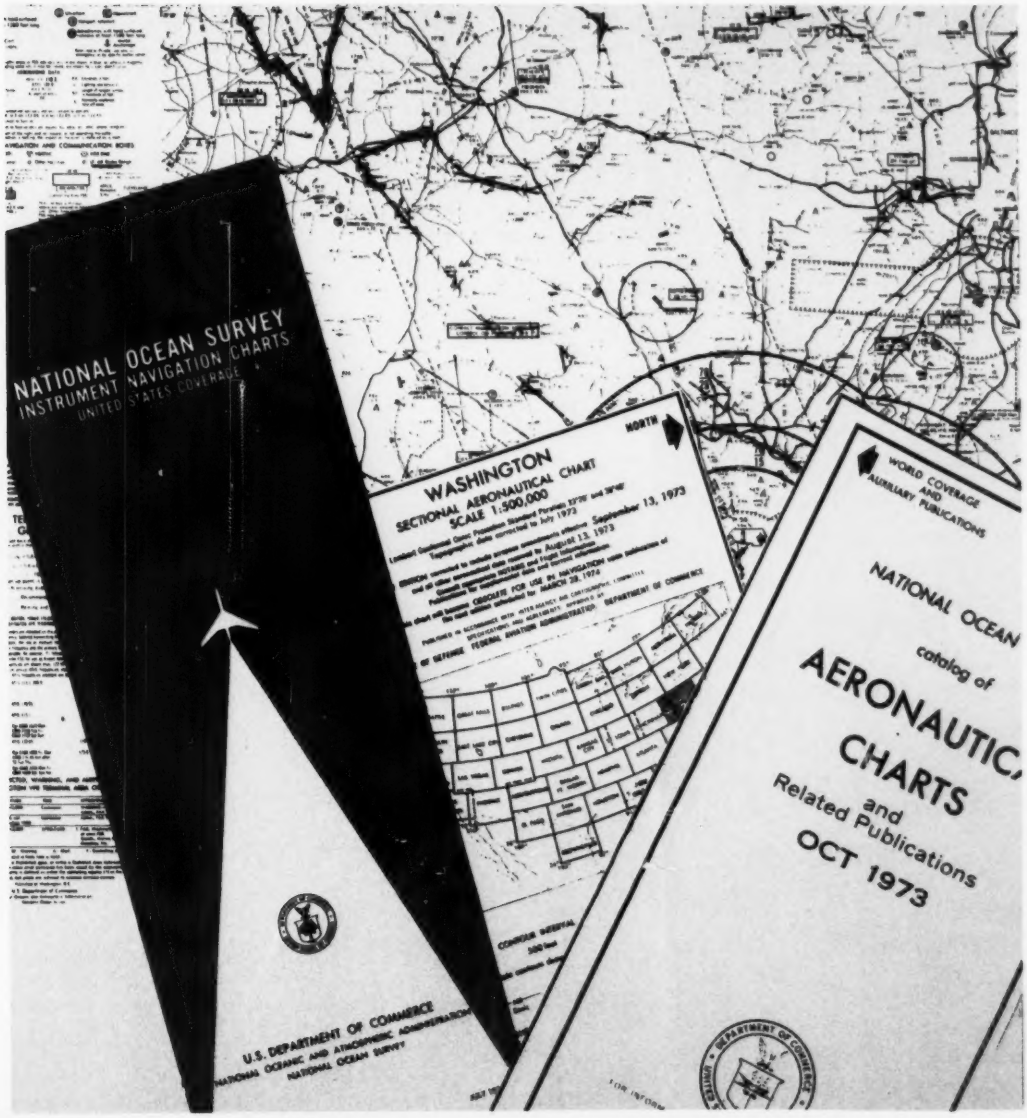

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